metal finishing Journal

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES.

Founded 1930 as the INDUSTRIAL FINISHING JOURNAL | Vol. 7 No. 81 (New Series) | SEPTEMBER, 1961

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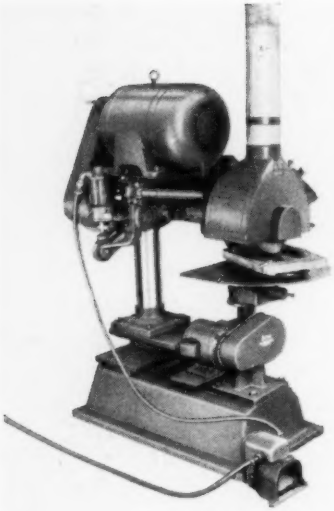

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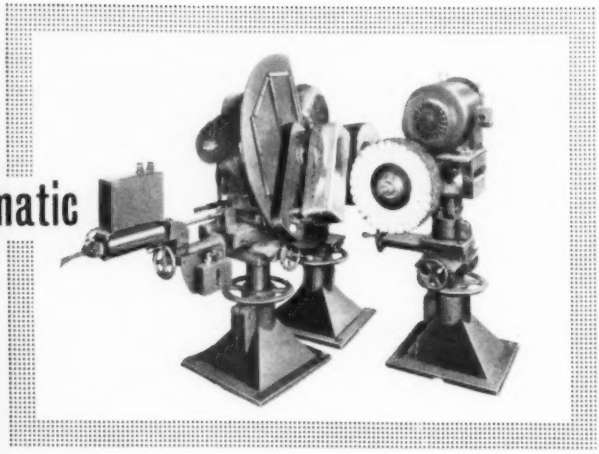

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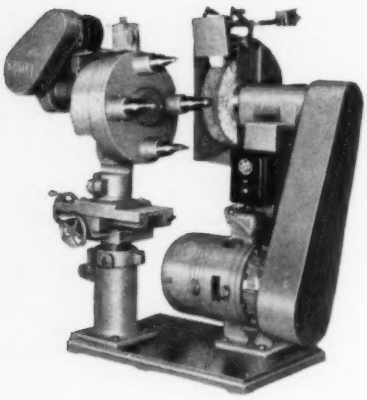

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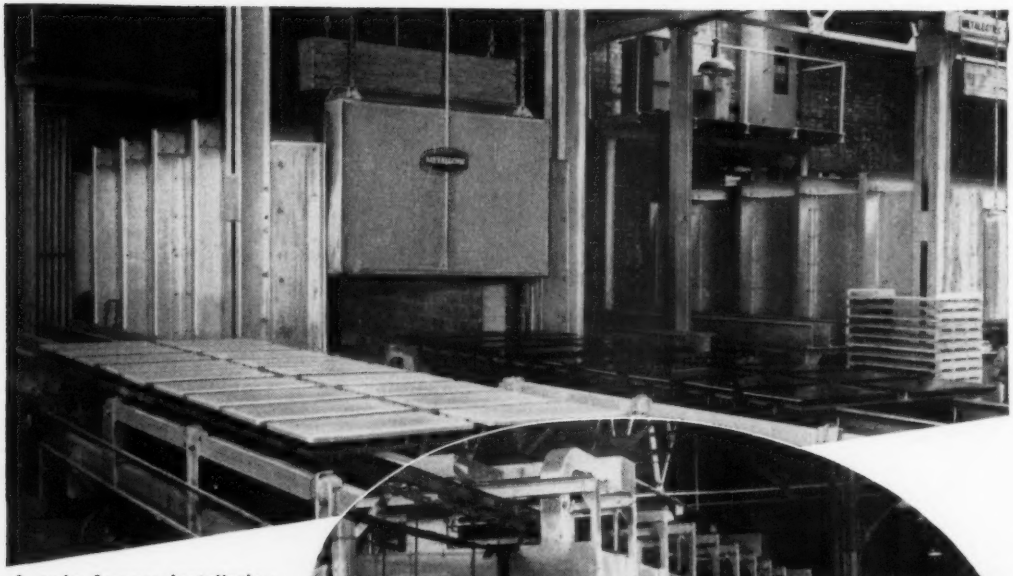
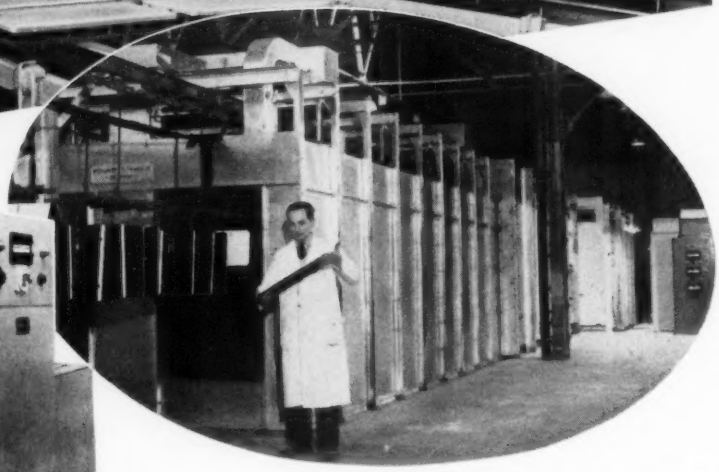
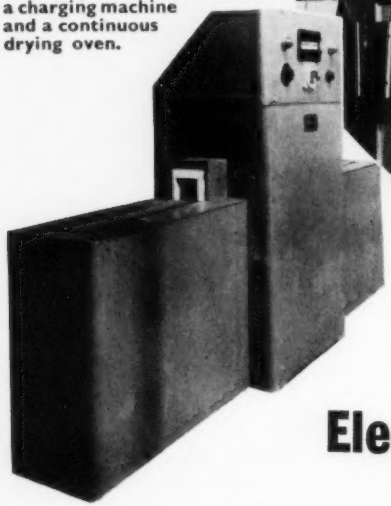


A twin furnace installation for fusing. The plant includes a charging machine and a continuous drying oven.



U type fusing furnace for sheet iron cooker parts. Output 1500 sq. ft. (3000 lb.) per hour. Rating 650 kW.



This furnace, rated at 10 kW, is used for badge enamelling.

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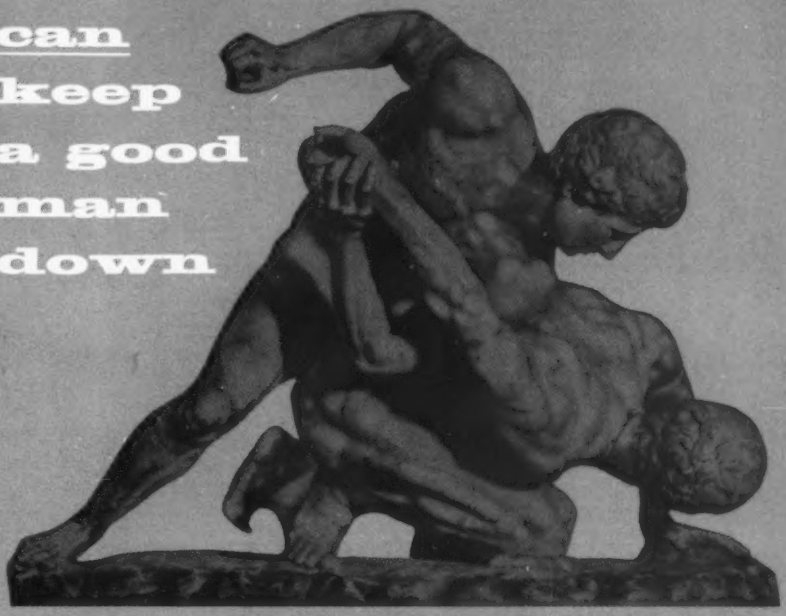

The Wrestlers, Florence, Uffizi.

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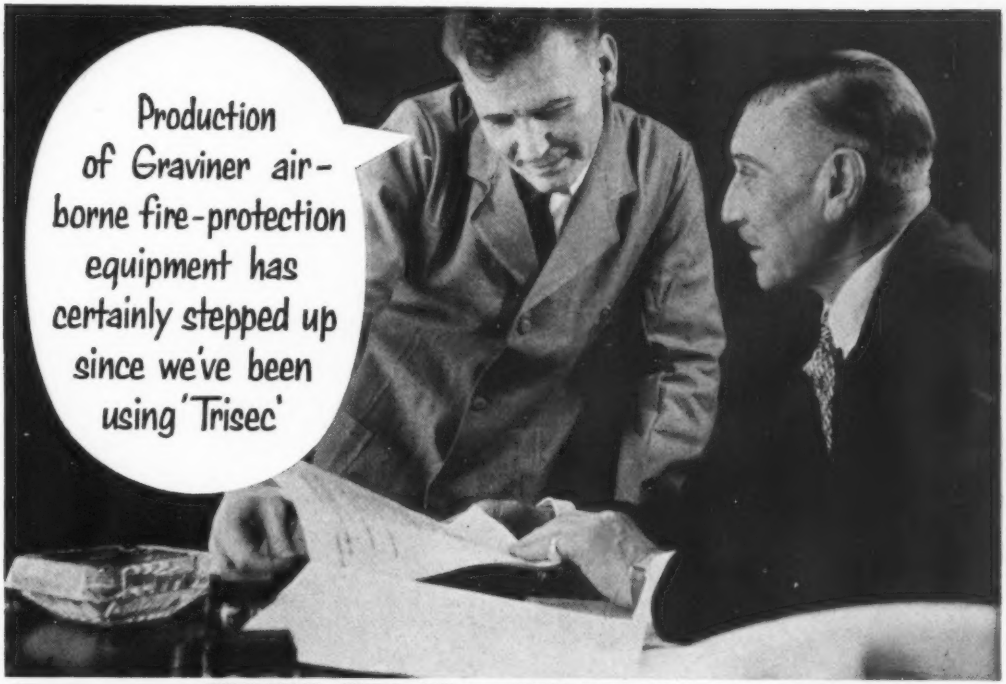

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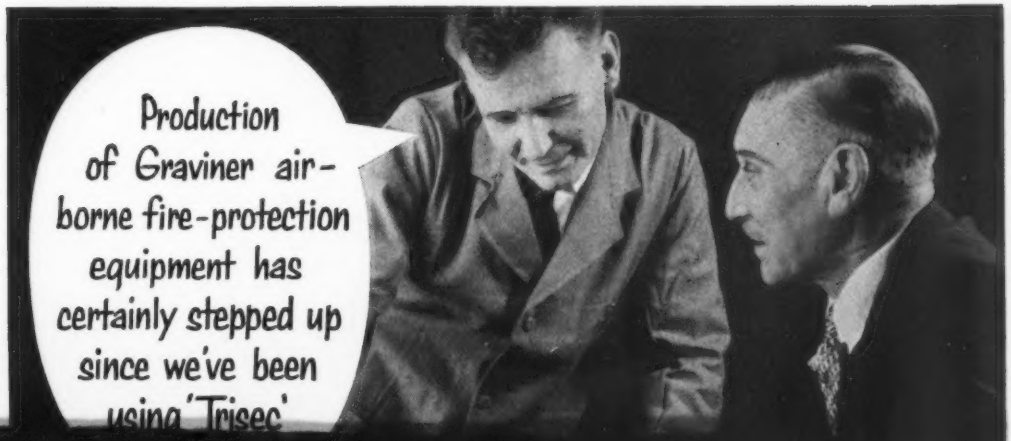

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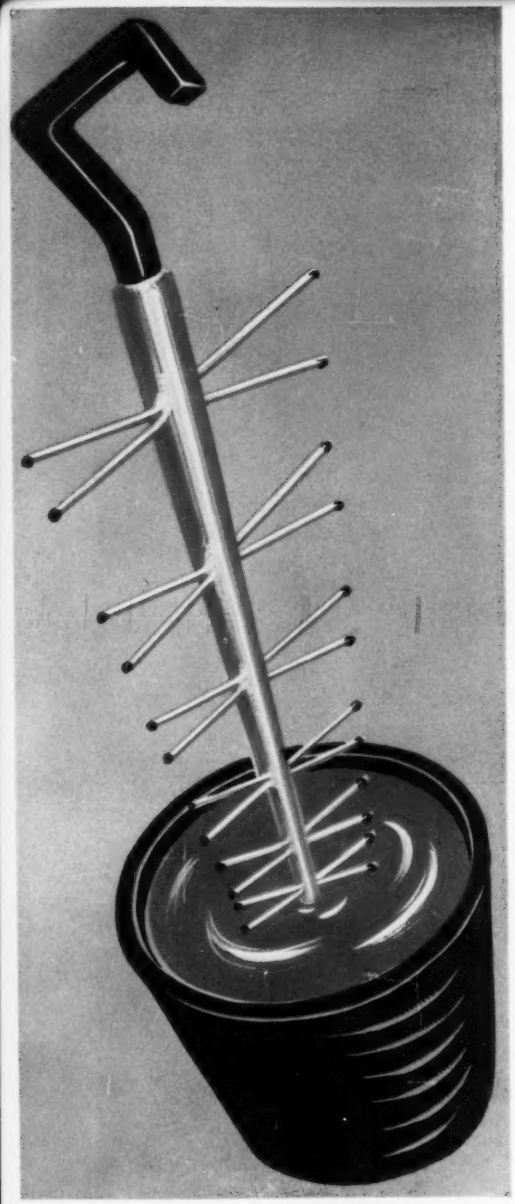

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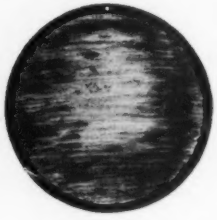
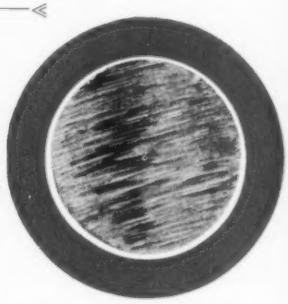
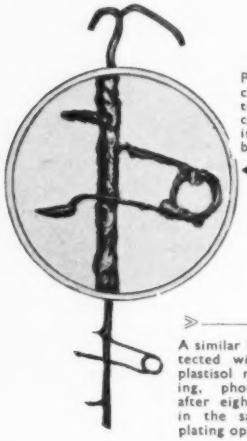


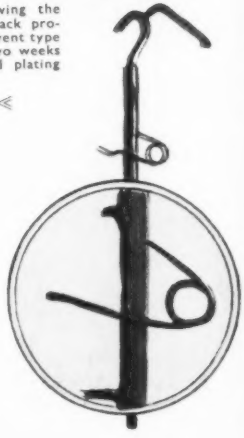
Enlarged photograph of a cross section of a typical rack member, which has had eight coats of solvent type rack coating applied to it.



The same member showing how Coating 218X builds up.



Photograph showing the condition of a rack protected with a solvent type coating—after two weeks in a severe lead plating bath.



A similar rack, protected with 218X, plastisol rack coating, photographed after eight months in the same lead plating operation.

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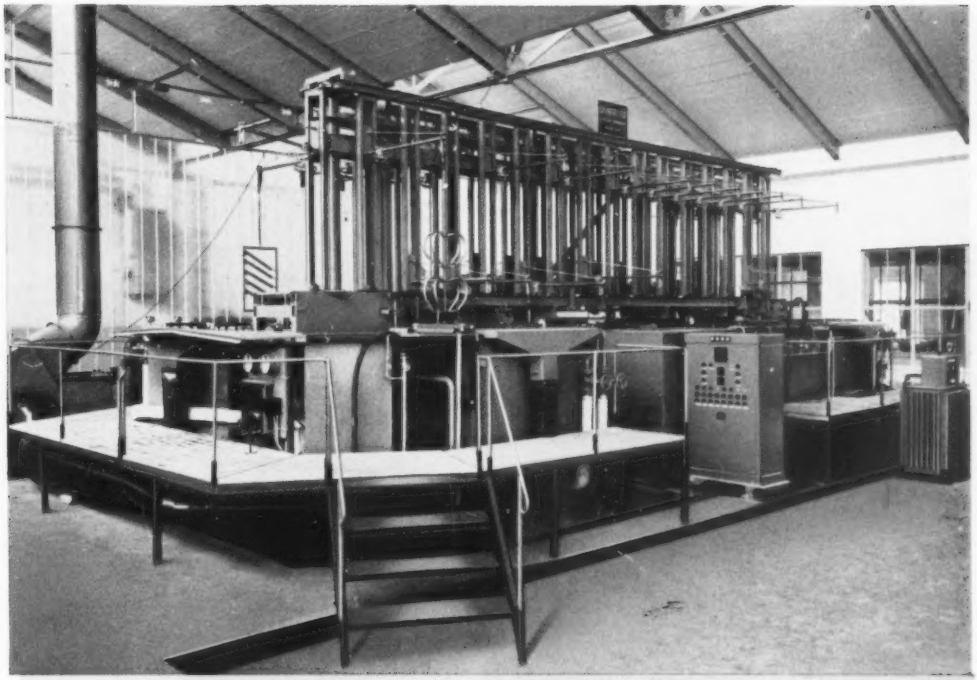

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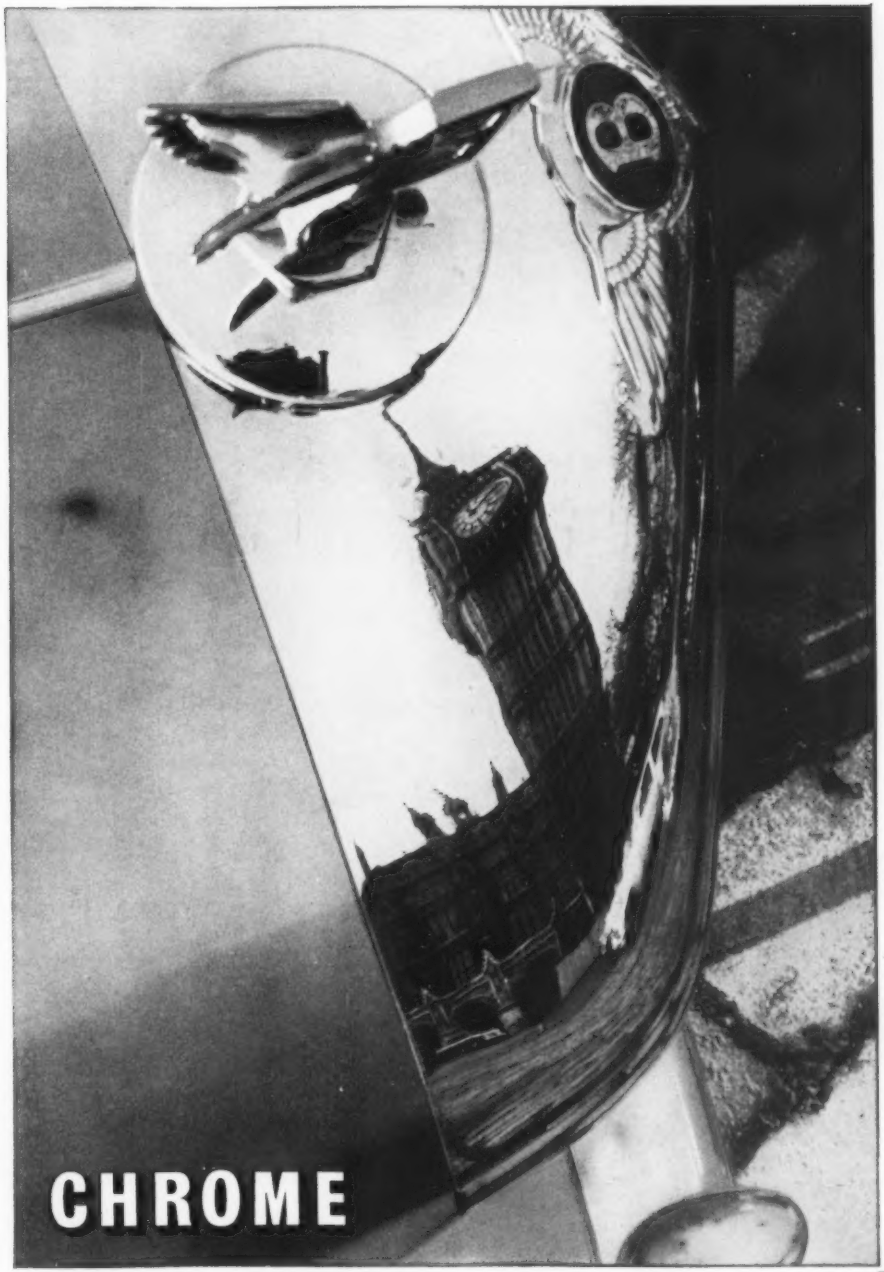

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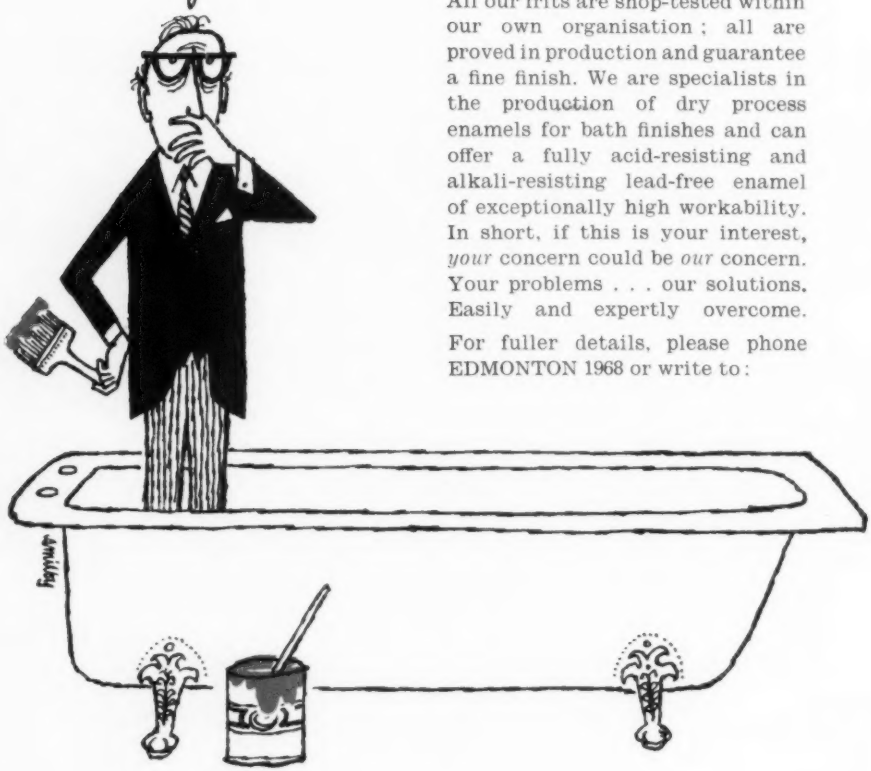

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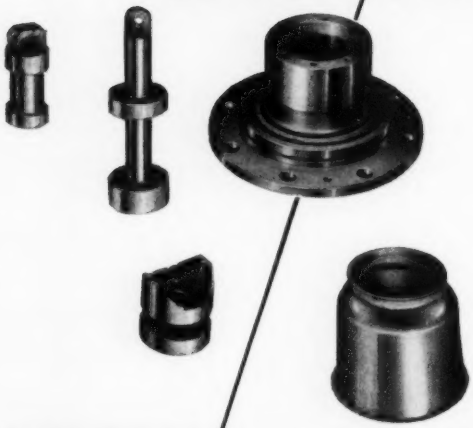

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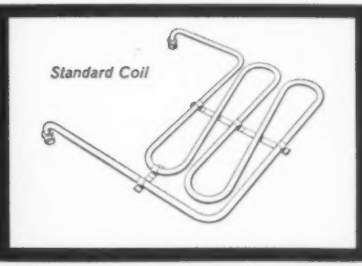

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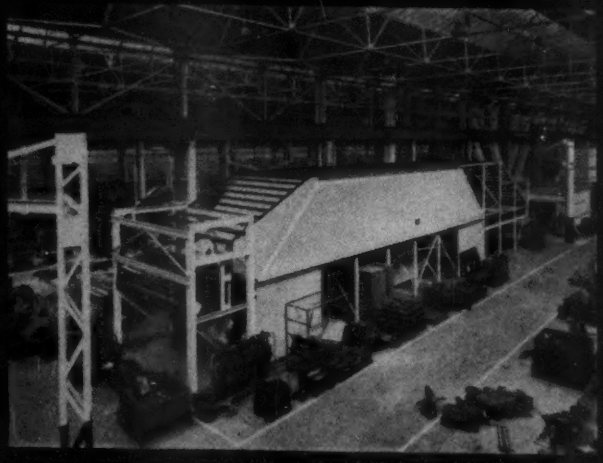

The photograph shows a large gas fired air circulated 'A' type stoving oven for both hand dipped and sprayed work, covering a wide size range and gauge of parts. Conveyor width 9′ 0″ with a clear hanging depth of 5′ 0″.

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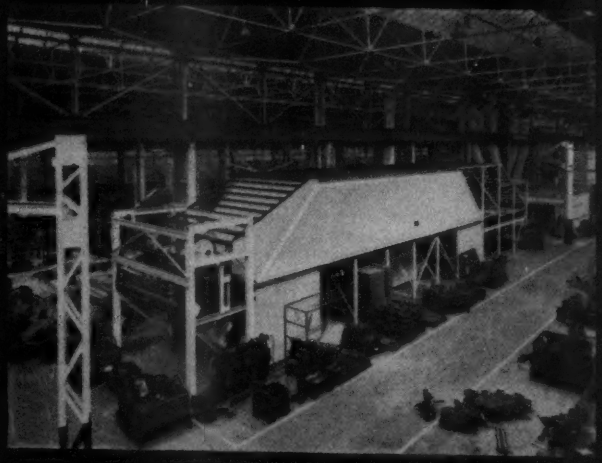

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IRREGULAR

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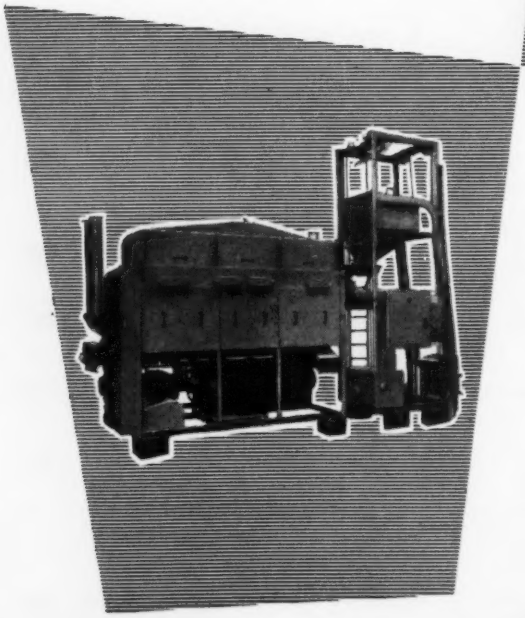
Washing Bolts and Nuts Down Under



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King Edward House, New St., Birmingham
Tel. Midland 3431

Manufacturers: **DAWSON BROS. LTD., Gomersal, Near Leeds.**
LONDON WORKS, 406, Roding Lane South, Woodford Green, Essex.

Tel: Cleckheaton 3422 (7 lines).
Tel: Crescent 7777 (4 lines).

TOO MANY SOWS' EARS

THE dangers of applying broad generalizations in special circumstances are clearly implicit in the facility with which it is possible to quote old saws and proverbs whose messages are mutually contradictory. On the other hand such aphorisms contain a sufficient germ of truth and applicability under certain conditions to lend them a sort of sublimal influence.

For example " Well begun is half done " can be very encouraging to the good beginners but may very well come to serve as a half-hearted alibi for the poor finishers. However well begun a job may be, it remains half done until it is well and properly finished.

This divorcement of finishing from beginnings is still a real one in the minds of many who are responsible for the design and production of manufactured products and there is still far too much evidence of abortive attempts to produce high-grade silk purses from what have all the fundamental properties of sows' ears, and still more regrettable is the tendency to blame the purse manufacturer for his lack of success in achieving the conversion.

Abandoning the aphoristic analogy, and expressing the point in terms relevant to the finishing industry, it is manifestly absurd to expect a finisher, who now has at his disposal a wider range of excellent processes than ever before, to produce his best work if the article he is called upon to finish lacks the basic prerequisites of the process involved. These prerequisites can involve not only the substance but also the geometry of the product. Recognition of this fact by the Institute of Metal Finishing resulted in the publication of a booklet setting out recommendations for the *design* of components intended for electroplating and polishing, but the significance of design in relation to finishing is still, in general, not given enough attention throughout industry. Too often the original design of an article is decided upon because it conforms to some " avant garde " notion of what is fashionable with no thought being given to subsequent operations ; in many cases a slight alteration would make possible simpler and therefore more economic finishing with the most important effect of improving quality and service life.

How deserving of praise therefore are those responsible for the new Vauxhall " Victor " which has been designed with the finishing processes in mind. The body of the car is free from moisture-retaining recesses, shelves and corners (particularly underneath the body) and the panels are of such a shape that the paint will flow well and adhere strongly whether applied by dipping, hand or automatic spraying. This design, in addition to the preliminary phosphate coating, allows the body to be completely dipped in black primer and the paint flows around the inner surfaces of the closed sections of the body structure through holes designed solely for the purpose. A further interesting feature is that polythene wax impregnated with aluminium filler is pumped by special guns into the door-sills. The remainder of the finishing sequence includes all-over red and grey primer surfacer and two top coats of a new enamel. Vauxhall's say that the new body is the result of a three-year process development programme with the main objective, *i.e.* the finishing sequence, clearly defined right from the earliest design stages.

Three years might seem a long time to spend on such a project, but the results will undoubtedly justify the time and effort involved.

What benefits might result if industry as a whole were to follow this excellent example!

Talking Points

by " PLATELAYER "

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

MISNOMER

THE recent failure of a prosecution against a paint manufacturer for allegedly describing a paint for bath tubs wrongly as a " porcelain enamel " had an apposite postscript a week or two later. This was in the form of a letter from a correspondent in a Sunday newspaper who had found himself firmly cemented to the bottom of his bath after re-painting it with a bath enamel which had softened under the action of hot water.

Of course, the prosecution would have been on surer ground if the defendants had called their product a " vitreous enamel," for example ; this, however, they were wise enough to avoid. In fact, taking a purely legalistic view, it is likely that by including a small quantity of ground porcelain in the mix, the defendants might have established a clear cut right to use the term " porcelain enamel " for their product. Nevertheless, the action was probably a good thing in that it may have helped to clarify the differences between the two types of finish in the public mind.

Organic finishing is a fast developing technology as compared with enamelling, where, by the nature of things, only marginal improvements are likely to occur. Perhaps in the years to come we may find organic " porcelain " enamel makers objecting to the application of the term to an inferior, brittle, refractory product !

CORROSION GAP BRIDGED

IT is wonderfully encouraging to learn of the protection against corrosion of a large steel structure as a factory operation, rather than as an after-thought when its erection has been completed. Nearly the entire steel work on the enormous new Forth Road Bridge will be put through two huge machines which will grit blast and spray it with a 0.003-in. thick coating of zinc, followed by an etch primer and three coats of paint. All of this will be done under cover and the steelwork will be stored in this way both before and after treatment pending installation. This will be quite an improvement on the existing Forth Bridge on which a paint crew has to work permanently all the year round.

Formidable as this operation is, anyone who has had any experience of instructing structural engineering contractors in the elements of corrosion prevention, would probably take the view that selling the idea must have involved nearly as much effort as doing the job! In any event, the cost of the processing of the bridge must be tremendous and it will be instructive to see how it works out economically over the years. This is probably the first time that a bridge structure has ever been finished in this way prior to erection anywhere in the world.

NO FINGER-PRINTS

JUST over a year ago, reference was made in this column to the fact that automatic plating plants only scratch the surface of the labour-saving possibilities in the industry, because no-one has ever begun to tackle the formidable problem of mechanising the racking and unracking operation. It is in fact, here that most of the labour used in plating is often required.

A glimmer of light, however, now appears on the horizon. An American firm has developed a machine which can simulate the movements of the hand, wrist and arm, and can carry out up to 200 sequential operations to a pre-determined programme. The actual operations themselves are worked out from the usual kind of time and motion study diagrams.

Although the development is still in its early stages, the long-term possibilities are immense, and may well revolutionise our entire approach to automatic plating installations.

SKILLED LABOUR

DO we set too great a store on the difficulty of carrying out some of the so-called skilled jobs in our industrial civilisation ?

This thought is prompted by reading a report that the Montecatini chemical group has set up a school at Brindisi in the rather primitive South of Italy to train its own labour to operate very complex chemical plant. At the end of the first three-month course, some 90 farm labourers were mastering mathematics, practical chemistry and physics with a facility that astonished their teachers.

Other examples of the way in which skills are rapidly acquired are innumerable. Mr. Gresham Cooke, M.P. recently reported how he had seen Yemenites who, six months previously had never seen a wheel, moulding automobile tyres in a factory in Haifa. In India, some of the most modern steelworks in the world are in operation. In Egypt, the Suez Canal is still open.

You never know what you can do till you try—but they don't always let you!

Some Thoughts on THE ECONOMICS OF LOW-PRESSURE SPRAYING

By J. MUIRHEAD*

(A paper presented at the Annual Conference of the Institute of Vitreous Enamellers)

MUCH has been said and a great deal written on the economies possible in the application of the surface coatings by the spray process. Many believe that these are possible, but only few have taken definite steps to effect the improvement in techniques which inevitably lead to the conservation of materials and reduction of costs involved in their application.

It is perhaps relevant to mention that in the field of organic finishing, careful formulation of finishing materials is of prime importance in obtaining a lasting high-quality finish or surface coating. Likewise, in the field of inorganic finishing, the careful compounding and formulation of vitreous enamel is just as important and essential.

The grinding of ingredients in both organic and inorganic materials is an important operation, although these materials differ in character. However, it is often necessary for adjustments to be made to the resultant mix to meet the specification of the coating job in hand.

The application of vitreous enamel must have the same consideration as organic materials when spray applied. The set becomes the controlling factor in flowing out and levelling on the sprayed surface. Many manufacturers of enamelled products have spent considerable time and effort in developing better enamels for their individual use, and many of the resultant developments are used by the trade generally. Better ground coats have been found that give greater adhesion to the metal, finishing coats with greater durability have been developed, and chemical research has made considerable information available today to relieve the industry of many of the troubles which have plagued it for a long time.

Those engaged in vitreous enamelling have centred their interest around such problems as better adhesion of ground coats, elimination of rusting, copperheading and fishscaling, and many other troubles in addition to developing finish coats with maximum acid and scratch resistance. These are of course only one or two of the issues to be contended with before much thought can be given to application methods.

However, the process of application cannot be passed over lightly, and more often than not, insufficient attention is paid to the all-important question of the methods and type of equipment used.

All manufacturers using finishing materials on their products must be interested in the best possible means of applying surface coatings and the elimination of waste. The question must therefore be asked " Can we afford to waste any material and incur excessive costs if by proper methods of control, and with very little effort such waste can be prevented." ?

Several methods may be used to apply vitreous enamel to a surface, but our interest is primarily in its application by the spray process, and in particular to study the economies possible by the correct and most advantageous use of modern technique and research in this direction.

The low-pressure method of spray application is now playing an important part in achieving such economies, and although many have believed in this method and have advocated its use, its general acceptance has been somewhat limited. This is mainly due to the reluctance to devote sufficient time to prove the undoubted economies and benefits which may be derived.

Consider what is meant by the low-pressure method of application. As the description implies, it is basically the use of lower air pressure for the atomization of the material, and involves some minor alterations in the equipment used in the form of the air cap and fluid needle combination of the spray gun.

A very important factor however is the change in technique of the operator. So that the economies and benefits of the method may be understood, a survey of the changes in equipment and technique is of course necessary.

In the past, and in some cases even today, atomization pressures of 70 lb. per sq. in and

* (Aerograph-De-Vilbiss Co. Ltd.)

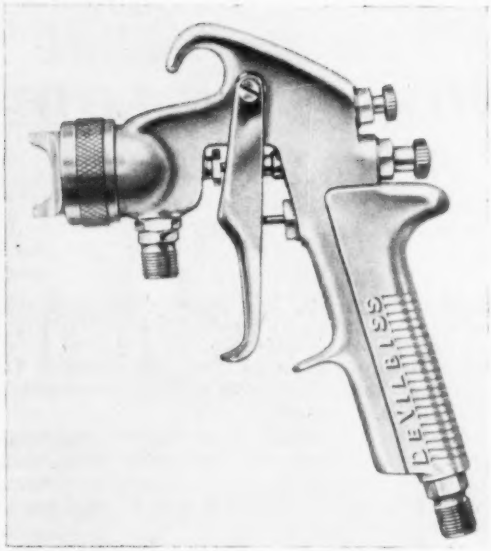


Fig. 1.—Manually-operated spray gun, Type JGA.

upwards were not uncommon, but by reducing these pressure to the region of 30 lb., the forward velocity of the atomized material in the spray cone is substantially reduced, resulting in a much wetter coat being applied, with more effective deposit of enamel on the surface of the ware being sprayed, and a marked reduction takes place in the amount of dust and overspray. At the same time, the distance at which the gun is held from the surface is reduced to approximately 10 in. as compared with the 18 to 22 in. formerly used.

The immediate result is a very definite saving in material because of the more effective coating of the surface. It will be appreciated that with the lower air pressure used, the amount of rebound is almost negligible, and considerable saving in material can be effected when spraying in enclosed areas. Operating conditions are greatly improved, and indirect benefits are derived from the much improved working conditions of the operator, his being able to see more clearly what he is doing and thereby avoid coatings which are too heavy or too light. Using these atomizing pressures of 30 to 35 lb. per sq. in., uniform coatings can be applied with smooth flow-out and a complete absence of pitting or unevenness of surface.

In the selection of equipment, care must be taken to obtain the best suited for the specific job and the type of enamel used.

A spray gun has three variables namely : the air cap out of which comes the air streams used for atomization, the fluid tip which meters the amount of material used, and the fluid needle which acts as a valve, opening or closing the fluid tip orifice.

In the past, the trend was to use as much air pressure as possible for atomization, and the largest fluid tip available in order to get the maximum width of spray pattern, and what all thought — the maximum speed. The aim today is to have a narrower fan width with a more concentrated effective pattern. With this it is possible to achieve the desired coating with the minimum of dust and overspray. Lower atomizing air pressures are the direct result, and as previously referred to, an example of the measure of success is the application of uniform coatings with as low as 30 lb. pressure with completely satisfactory results.

Control of the atomizing and fluid-feed pressures necessitates first of all having spray equipment accessories that function properly. An adequate supply of compressed air is essential and the air compressor must have sufficient capacity to furnish an unfaltering supply of air equivalent to and preferably in excess of peak demand.

In order to achieve the full benefits, certain modifications are made to the type of air cap and fluid tip used, in addition to a variation in the spraying technique. It is not merely a matter of lowering the pressure, since this would only result in upsetting the break-up of the enamel and cause untold problems.

The results obtained in using these specially designed air caps have been truly remarkable, and because of the effective concentration of spray pattern with a much lower degree of impingement on the surface being sprayed, a much more readily controlled application is possible with a wetter coat and improved flow-out.

With the trend toward lighter application, it is essential that a positive control be instituted over the pressures used. To maintain this pressure, accurate means of regulation is essential at each spray station, unless as is the practice in some plants, a central control is maintained and adjusted by supervisory personnel.

Fluid-feed pressure control is also important. With the smaller fluid tip orifices used in the spray guns, the fluid pressures are likely to be slightly higher than with the larger ones. This is so because of the more accurate degree of metering afforded by the smaller orifice. The proper fluid pressure for the material in use must however be determined by tests and then maintained.

Mention has been made of the basic changes in technique to be adopted, and a system of control over the operators methods of work is therefore necessary. A disturbingly high percentage of spray operators have become fixed in their ideas regarding the need to use high pressure, and it is not unusual to find operators under the impression that all is

not well unless the spray gun in their hands is unleashing tremendous energy in the form of a very wide spray pattern, with all the force behind it that the available air supply can muster.

This is fundamentally wrong, and a campaign of re-education is constantly being recommended by manufacturers of spray finishing equipment in their endeavours to assist in the reduction of costs by way of material conservation, savings in compressed air and perhaps most important of all, making the operators' job easier and free from fatigue.

Perhaps the simplest and easiest part of introducing the low-pressure spraying method is to effect the few minor changes in equipment involving the alteration of the air cap and fluid tip combination, but unless the operator fully understands the purpose of the whole exercise, the full economies to be gained will be completely nullified.

Operators in so many instances are in need of training although they may have had many years of experience in finishing. What they have learned is what they have acquired themselves by the use of the equipment. This self-taught spray technique often proves to be the wrong procedure to follow where the greatest economy, with highest quality and production the goal.

Sufficient care must therefore be paid to the control of spraying technique, not only by instituting some rule of thumb instructions, but by intensive instruction and training of operators.

If this cannot be undertaken by the employer or his staff, it will be gladly carried out by the spray equipment supplier either at the customer's plant, or at one of the many training courses regularly held by most equipment manufacturers.

It may be considered inevitable that a slowing-up will take place when the low-pressure system of spraying is employed. When all factors are taken into consideration such as reduced overspray and wetter film surface with more even application, the difference in spraying time is by no means out of proportion. The average operator working with pressures of 60 lb. and upwards will spray a surface in various directions several times to obtain the required coating thickness. However, with lower pressures an equivalent weight of coat and effective coverage can be applied by steady, uniform strokes, with one pass over the ware and overlapping each stroke 50 per cent.

Motion study has proved that the small difference in time taken to spray a uniform coating on similar areas is negligible.

Instead of the all too common haphazard whipping or fanning of the spray gun, the motion should consist of a smooth rhythymic non-tiring stroke, with the gun held perpendicular to the surface at all times. Rather than carrying the gun beyond the edges of the work, and consequently wasting material at each end of the stroke, the gun should be started and stopped at the beginning and end of each pass. A uniform distance from the work should be maintained, with the correct overlap.

If such basic and what may seem elementary procedure is adopted, results will, in a very short space of time show economies which will more than repay any time and effort expended.

However, as is the case in any training programme, the backing and support of supervisory personnel is essential. The important part played by the operator becomes evident, as does the necessity for the careful selection of spray operators. Any scheme which involves changes, however slight, must have something in its favour to ensure success, and today's conditions make any form of economy most welcome and worthwhile. This is particularly so because of the intense competitive situation which exists with other methods and materials used in surface coating in the organic finishing field. Every possible clue must be followed to effect lower costs and improve quality. Costs can be lowered by saving material, reducing rejects, finding and adopting new methods of applying vitreous enamel.

Such lowering of costs is the direct outcome of using the low pressure method, affecting material, labour and equipment.

With the smaller width of spray patterns providing more effective coverage over the area of the spray pattern, the amount of material handled through the spray gun is reduced to the essential minimum. The wear and tear on the parts in contact with the material consequently lessens and replacement of parts is less frequent. There is less enamel being shot past the article being sprayed and therefore less need for reclamation. Savings in enamel slip are reflected in the amount of overspray collected from the spray booths.

It is on record that one company has effected a saving of some 25 per cent in material usage since adopting this system. Proper spraying technique means less fatigue to the operator, and therefore ensures more efficiency throughout the working day.

To reach the ultimate in quality finish is not the responsibility of management alone, but all involved must accept a share of responsibility in the development of better controls, and establishing and upholding application standards.

The basis of any programme of economy or lowering of costs must inevitably start with the establishment of some standardisation. Material control presents some problems since many variables enter into the picture and one must take into consideration factors applying to any particular job or working conditions such as the type of ware, the manner in which the ware is sprayed, and the technique used.

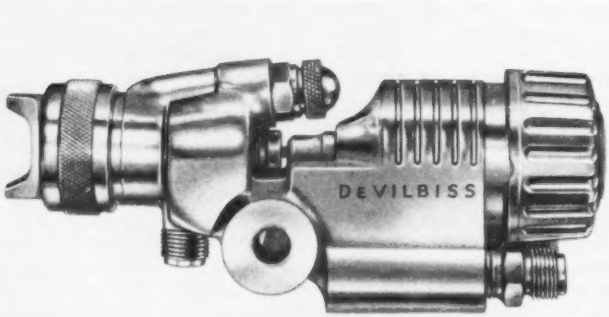


Fig. 2.—Spray gun for automatic configurations, Type AGA.

It is not intended to leave the impression that the spray equipment manufacturer is an authority on the compounding or formulation of vitreous enamel, nor in possession of the know-how to meet any requirements of the trade. However, constant association with the application of these enamels has highlighted the fact that all vitreous compounds do not react the same during the process of application. Some enamels are more difficult to apply with the spray gun than others, although only slight changes may be found in their respective formulae. There are many formulae for making vitreous enamel, and one ingredient may counteract or balance another which may be desirable for firing reasons, or it may assist in making a more durable product or it may make for easier application. However, if a change is made in the formula, the sprayability of the material should be rechecked, since some slight adjustment may be necessary in the spray equipment used.

When establishing enamel control, it is most advisable to seek the co-operation of the frit manufacturer or supplier, since he is familiar with the particular frit being used, and any permissible alteration in its formulation. The recommendation is made to use as high a specific gravity as possible, and to hold the set fairly low. The set should not be so low that the material will sag on the ware or settle out in the pressure feed tank, although this latter point can largely be overcome by effective agitation in the tank.

When using titanium enamels, the specific gravity may be as high as 1.80. More density means less volume of material to atomize because of the reduced quantity of water. The sprayability of the enamel slip may be controlled by the amount of set used — the lower the set, the easier it is to atomise the material, and provide a wetter coat.

These two features figure largely in the low pressure method of application, and should be sought after as a first principle.

As may be seen from what has been said the best combination of specific gravity and set must be determined for each particular job. The correct combination can be determined by working out the solution on a gradual scale, and may take a period of time, but always in co-operation with the frit supplier.

All that can be said is to determine largely by trial and error the best set combination for any particular job or conditions, establish that as a standard, and hold it there by control.

In making any material change by altering the set, it is suggested that it be done cautiously, possibly by changing the pick-up 5 gm. or the slump $\frac{1}{4}$ in. per week. By doing this, the finish will be gradually improved, no one will get into trouble, and a quality standard is maintained while the change is being made.

To test the sprayability of a newly formulated enamel, and before sending it to the finishing line, the proper procedure should be adopted. Similar conditions of material feed method and equipment used should be applied to the tests to give accurate assessment of results to be expected on the shop floor. Use the same type of spray gun, equipped with a similar air cap and fluid needle to that used by the operator on the line. Needless to say, records should be made of the fineness of the grind, the type and amount of set used. Attention should be paid to the atomizing and fluid feed pressure, and a check made on the rate of material flow from the gun.

From all this it will be possible to work out the area in square feet which the operator can coat in one minute, with a given weight of coat, and by controlling the pressure on the material feed container accordingly, a standard may be established in applying the correct volume and weight on each piece of ware as required.

By lowering the atomizing pressure, from say 70 lb. to 30 lb. and using the specially designed air cap to give perfect atomization at the lower pressure, a saving of roughly 5 cubic feet per minute in the volume of compressed air used is possible. By

(*Continued in page* 336)

Metal Finishing Technology — A Students' Guide: 9

An Introduction to the Examination Syllabus in Metal Finishing of the City and Guilds of London Institute

Compiled by A. ALEXANDER

Crystal Structure and Related Properties

Structure of Metal

IN describing the metal solution interface it was said that the metal was composed of a number of atoms which were arranged in a lattice, the atoms being held in place by the circulation of electrons. Over a small area these atoms are arranged in regular groupings but if a larger piece of metal is considered it is found that it is divided up into a number of small crystals, that is to say pieces of metal in which the atoms are arranged in a regular manner but that the lattice planes in one crystal would be at an angle to those in another adjacent to it.

In order to understand the properties of a metal it is extremely important that the student should be able to form a picture of its structure. The real test of a crystal is not the outside appearance but whether the atoms from which it is built up are arranged in regular planes. Thus a crystal of metal will not be transparent and may have quite irregular sides but it will none the less be a crystal because of its internal structure. A piece of metal will normally be composed of a number of these crystals set at various angles to one another Fig. 1. If a piece of cast iron is broken and the fracture inspected the crystalline structure can be seen, similarly if a piece of brass is polished and etched with nitric acid. These crystals may be quite small but in certain instances by employing specialized techniques quite large single crystals of metals can be obtained, large enough to handle, with the planes of atoms running through from one side to another.

Consider a single crystal of a metal, it will be found that its properties differ from the original piece of metal of the same size composed of a number of crystals. A single crystal will be softer and easier to deform, but usually, if deformed it will break up into a number of small crystals and will then become harder and have similar properties to the original piece. This is because when a metal is deformed the atoms of one plane slide over the top of another plane making it easier to deform the metal when all the atoms are in one plane.

A very simple experiment was devised to show

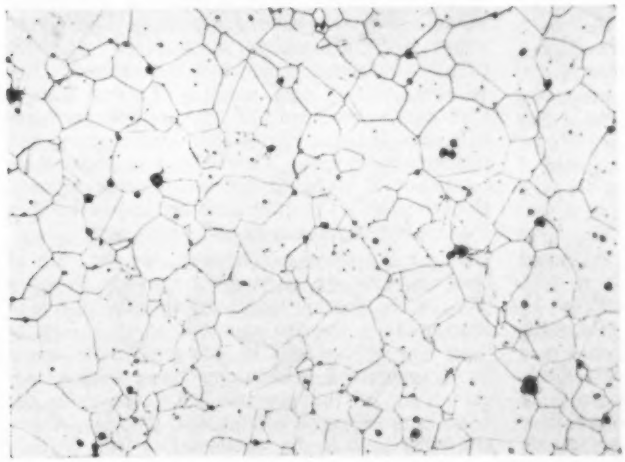


Fig. 1.—(x100) Structure of annealed metal surface showing crystal boundaries.

this effect. If a fine jet of air is blown through a nozzle submerged in a tray of soapy water the small bubbles so formed will arrange themselves on the surface of the liquid very much like the arrangement of atoms in a crystal lattice. If a slight pressure is exerted on each corner of the " bubble " lattice it will be found that the bubbles do not move relative to one another but just squeeze up. If the pressure is released they go back to their original position. If, however, the pressure is increased slightly there comes a point when the whole of one row of bubbles slides over the next row into the next position, that is to say they all move alone one. If the pressure is then released the bubbles will stay where they are and will not go back to their original position.

This is exactly what happens if a piece of metal is bent. The metal is found to be somewhat springy and if a small force is applied the metal will bend but will spring back to its original shape when the force is withdrawn. If, however, a larger force is applied the metal will not spring back to its original shape but will be permanently bent. The point at which the metal takes a permanent bend, and which depends on the nature of the metal and its structure, is called the modulus of elasticity.

When dealing with metals, therefore, it is important to remember that when deformed the metal tends to " give " along the lattice planes of the crystals and that there is not very much motion between the crystals themselves because the crystal is softer, that is to say more easily deformed than the boundary between two crystals.

Remembering this it will be seen that normally the larger the crystal of the metal, the softer and more easily deformed the metal will be. If therefore it is required to soften a metal, the crystals in it must be made as large as possible, whereas if the metal is to be hardened the crystals must be made as small as possible.

It is possible to alter the size of the crystals of which a metal is composed ; for example, to soften a piece of copper, that is to make the crystals larger, can be done by heating to a low red heat and then allowing to cool. When heated the larger crystals tend to grow at the expense of the smaller ones. This is because when hot it is easier for the atoms to move from their original positions and take up a new position. The large crystal will exert a force on the atoms lying round its edge and will tend to pull them into its own lattice structure. Normally this force will not be sufficient to alter their positions but when the metal is hot and they move more easily they may very well alter their position to take up a position in the lattice structure of the large crystal. In this way the larger crystal tends to grow in size whereas the small ones tend to disappear and thus a piece of metal composed of relatively large crystals is obtained which will be relatively soft.

If this piece of metal is then hammered, the effect will be to break up the larger crystals by pushing the atoms in them about until they take up different positions with regard to the original lattice. It will be found that if the piece of soft copper is hammered or deformed in any other way, the crystals will gradually break up giving a finer structure and becoming harder.

This, of course, is the simplest case, that of a pure metal. When dealing with alloys other factors also affect the hardness of the metal but since the large majority of electrodeposits consist of pure or nearly pure metals the example given above is characteristic.

It has been shown how the crystal structure and therefore the mechanical properties of a piece of metal can be altered. However, the original piece of copper can be produced with large or small crystals according to the process used. For example when making a casting, the more slowly the molten metal is cooled in the mould, the larger the crystals obtained. A chilled casting, for example, which is made by pouring the metal into a cold steel mould which conducts away the heat quickly will have a fine structure, particularly on the surface of the casting and therefore will be harder than one that is made in a preheated sand mould. It is well-known that the more slowly a salt is crystallized from a solution the larger the crystals obtained. One can, for example, grow some very large and beautiful copper sulphate crystals by very slowly cooling a saturated solution of copper sulphate. However, if the solution is cooled quickly quite small crystals are obtained. The same thing of course happens when a metal is cooled.

When, however, a deposit is produced by electrodeposition the process is analagous to the crystallization of a salt from a solution. The crystal structure of the deposit may be changed by altering the conditions under which it is produced. If a solution with a large number of metal ions is electrolized very slowly on to a suitable surface it will be found that the crystals tend to grow to a relatively large size. This is because under these conditions it is easier for the discharged metal atom to take up a position in an existing lattice than to start forming a new crystal on its own.

The metal atoms will always take the path of least resistance, and it is easier for them to find a place in the existing lattice if they have plenty of time to do it than to start out on their own to form a new crystal. If, however, there are a large number of these atoms being released together and if the potential difference from the solution to the metal is large, that is to say, if they are being shot at the metal surface with a fairly

large force, they are more likely to end up in a knot thus starting a small crystal of their own in which the planes are arranged at a different angle from those of the original. Thus a deposit with a fine structure will be obtained and this, as previously shown, will be harder.

This effect will be found in practice, for example if one deposits a metal at a low current density and high temperature, the crystals will be relatively large and the deposit soft, whereas if deposited at a high current density and a low temperature, the deposit will be relatively hard. In practice, however, there are a number of other factors which affect the deposit and in fact influence it a good deal.

One of the factors which has the greatest affect on the structure of a deposit is the presence at the cathode surface during deposition, of atoms or molecules other than those being deposited. For example, if copper atoms are being deposited on a copper surface at a fairly slow rate they will tend to take up the structure of the existing crystals at the surface. If however, some gelatine, is introduced to the solution, the molecules of the gelatine will find their way onto the copper surface and will adhere to it. This will of course break up the structure and the copper atoms being discharged will no longer be able to take up the position in the existing lattice and will start to grow new structures on the surface of the gelatine molecules.

Thus if gelatine is added to an acid copper solution a finer grained, hard deposit is produced. If too much gelatine is added the deposit becomes brittle and even discontinuous. If the deposit is carefully analyzed it will be found to contain organic matter probably the gelatine as such.

It is extremely important to understand the mechanism by which deposits of various structures are produced. By varying this mechanism the structure of the deposit can be varied and a metal of the required physical properties produced. On the other hand, however, various conditions which are not controlled or are unknown may cause the deposit to vary in an undesired manner. It must, therefore, be possible to control these conditions and also have a clear picture of the conditions so that any trouble can be diagnosed and remedied.

Crystallographic Examination of Deposits

If a deposit is obtained from a process which is unsatisfactory one of the first things to do is to examine its crystal structure. It is generally better to examine a section of the deposit as the various troubles are more easily interpreted from this than from looking down on the surface of the deposit.

To make the examination therefore a piece of the specimen is cut in such a way as to produce a section of the deposit at right-angles to the surface. This section is then mounted in a suitable material. If dealing with a copper or nickel deposit on steel or brass the specimen can be mounted in Bakelite in a moulding press by surrounding the specimen with Bakelite powder and squeezing it into the press and heating it to the curing temperature.

Fig. 2.—(x100) Section of deposited nickel showing crystal structure.

This method can be used for the majority of specimens but it must be remembered that the temperature to cure the Bakelite is fairly high, usually about 180 C. and this temperature itself will sometimes produce changes in the deposit, especially near an interface. If there is any danger of this, a cold setting resin should be used to avoid heating the specimen. When the speciman has been mounted the face is very carefully ground down with abrasive paper and using white spirit or some other suitable material as a lubricant. Papers of finer and finer grit are used until all the scratches have been removed leaving a smooth surface which can finally be polished on a piece of Selvyt cloth using finely precipitated alumina.

This is by no means easy to do and requires a good deal of experience and very careful handling, but if properly done a highly polished, absolutely flat surface should be obtained. This can be examined under a metallurgical microscope which is a microscope which has an illuminating system throwing light vertically through the objective on to the specimen.

If a polished specimen, prepared in the manner described is examined, the deposit and the interface between the deposit can be seen and also the basis metal, but no crystals in the deposit can be identified. If, however, the specimen is carefully

etched in a suitable solution the crystal structure is shown up and will probably be composed of long shaped crystals running out from the interface Fig. 2. This is called a "reguline" structure.

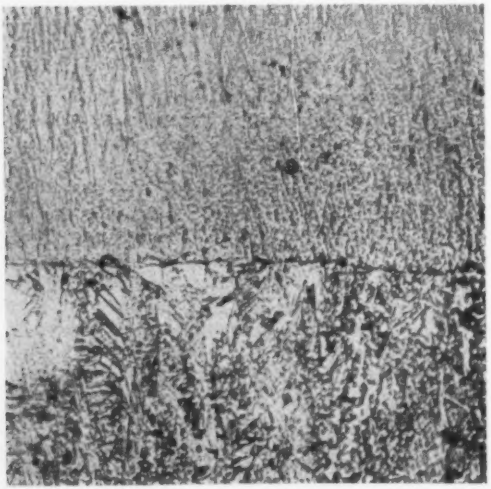
In some instances, however, the crystal structure will be very small and may be completely invisible Fig. 3. and all that is obtained by etching is a number of stress bands running almost parallel to the inferface. This type of structure is obtained when examining a bright nickel deposit produced from solutions containing organic brighteners.

In some cases impurities can be seen in the deposit, cracks running right through it, foreign bodies included in it, blisters, nodules and areas of non-adhesion at the interface. If these various imperfections are examined under a high magnification it can be decided what caused them.

If a soft nickel deposit is being built up from an ordinary nickel sulphate solution without addition agents the deposit should have the long regular crystals mentioned above. If, however, on examination it is found that the crystals are small and there are evidences of a banded structure then it is fairly certain that the solution has become contaminated with some kind of organic matter. Under these circumstances an attempt should be made to remove this matter by treating the solution with an oxidizing agent such as hydrogen peroxide or Potassium permanganate and then passing it over activated carbon. If after this treatment the desired structure returns it is fairly certain that the trouble was caused by contamination and that it has been removed.

Of course, it is not necessary to examine the deposit sectionally in order to do this, often an examination of the surface or by bending the article and seeing if the deposit cracks indicates whether the structure of the deposit is correct. However a metallurgical examination is of considerable help and often throws considerable light on the nature of the trouble.

Fig. 3.—(x300 approx.) Section showing composite deposit of nickel. (top) small crystals, hard deposit. (bottom) large crystals, soft deposit.



The metallurgical microscope may be used to examine the average deposit produced by electrodeposition but in many cases particularly where addition agents are being employed to produce bright deposits or in the case of a metal like chromium, the structure of the deposit may be too fine to see under the highest magnification. There are certain other techniques which can then be used to obtain information about this structure. For example one can use an X-ray defraction apparatus. In this instrument a beam of X-rays is shot at the metal surface and the reflection from this surface directed at a photographic film. The X-rays are diffracted by the various crystals in the metal surface and form definite patterns from which the size and other physical properties of the crystal may be calculated.

Electron diffraction apparatus may also be used but all these techniques are usually only applicable to research laboratories having the necessary equipment and have to be employed by experts. While an electro-plater may be expected to be able to prepare and examine a section by the ordinary metallurgical method these more advanced techniques are outside his sphere and it is not proposed to describe them.

Effect of Impurities

It is probably true to say that many of the troubles found in electro-plating processes are due to the effect of various impurities sometimes in extremely small concentrations. The average plating shop will control the major constitutents of their solutions with reasonable accuracy and in the majority of solutions small changes in the composition produce very little effect in practice. When trouble occurs it is usually due to the fact that some undesirable substance has got into the solution and this is very often difficult to find because quite small amounts of some impurities will produce a very marked effect on the deposit. The reason for this will be seen if one considers again the action taking place at the cathode surface. If one imagines for example, a nickel plating vat and thinks of a number of nickel atoms being released at the surface of the article being plated and starting to form up in a regular manner, one soon realises that even one or two foreign bodies, particularly if they are fairly large organic molecules, which may be 100 times greater or more in size that the nickel atom, may produce a very marked difference in the positions which these nickel atoms will take up. Unfortunately in practice it is very

difficult to keep out all foreign matter from a solution. Some grease or other material may be carried into it with the work which is being entered or contamination may take place from the material of which the tank or other apparatus is made and with which the solution comes in contact. Again there is a certain amount of airborne contamination, for example people dropping cigarette ash into the tank or even perhaps flies or other insects becoming drowned in it.

With modern organic bright nickel solutions there is an even worse trouble, breakdown products may form from the brighteners, wetting agents, etc. that are intentionally added to the solution to produce the desired effect. Some of these compounds may also produce addition compounds with impurities such as grease which enter the solution through imperfect cleaning of the work. In point of fact when one comes to think of all the ways in which a solution can become contaminated it seems almost miraculous that satisfactory deposits are obtained at all.

Apart from organic material there is also a certain amount of contamination from other metals. The supply of metal being deposited comes normally from the anodes. While these are commercially pure they are not completely free from other impurities. A nickel anode for instance will have a small amount of iron in it and may also have small quantities of copper, zinc and other substances. Metal will also enter the solution from the articles being plated which may dissolve slightly in re-entrant portions such as screw-holes, etc. or which may become detached and fall to the bottom of the tank slowly dissolving into the solution.

For example in a nickel solution there will be a small proportion of iron and an even smaller, though probably detectable, amount of copper with a possibility of some zinc and lead. If zinc-based die-castings are being plated the zinc content may become relatively high.

All these metals will deposit out with the nickel. Copper will deposit at a lower cathode potential than nickel and will therefore deposit out preferentially. Iron and zinc will require a higher cathode potential but will normally also deposit out under the conditions in a normal plating vat. Again these foreign atoms being deposited on the cathode surface will tend to break up the regular crystal structure forming either new crystals and therefore a harder deposit or producing distortion of the lattice of the crystal that is forming with increased stress in the deposit and generally increased hardness.

Analytical tests are available for detecting small quantities of metallic impurities in nickel and other plating solutions and it is therefore possible by carefully testing in the laboratory to find out whether the solution has been contaminated in this way Often also it is possible to determine this by a careful examination of the plated article. For example, if one is nickel plating copper kettles and a dark area is produced where the spout joins the body, that is, in the low current density area, it is fairly certain that the trouble is due to contamination by copper because copper tends to deposit preferentially in this area and will therefore produce the greatest effect there.

If a very bad contamination is experienced it may be necessary to treat the solution chemically to remove it, but with the more normal type of trouble one can usually work the copper or other impurity out electrolytically. As mentioned previously, copper will deposit preferentially in the low current density areas and so if a fairly large cathode is placed in the tank and a low current allowed to flow to it for some time, a large quantity of the copper can be worked out and the trouble rectified. In some cases it is found desirable to circulate the solution continuously through a small treatment tank in which the metallic impurities in it are worked out in this way.

One usually finds in practice that solutions work best when they are continuously kept working and that after a period of rest, for example on a Monday morning, they have a habit of giving trouble. This is often due to the fact that some small quantity of impurity, for example from a tank lining, is continuously entering the solution. During the week it is being worked out of the solution as fast or faster than it enters but when the solution is left idle the impurity accumulates until it gets to a concentration when it produces an undesirable effect. If it is found that solutions give trouble after weekends or holidays or when they have been put aside for some time, this effect may be suspected and a careful examination should be made to find out the source of the impurity.

Metallic impurities may be analytically estimated but it is usually extremely difficult, if not impossible, to estimate organic impurities in this way even when the solution contains no intentionally added organic matter. In the first place it is usually not known what the impurity is and therefore it is difficult to test for it. In solutions which do not contain brighteners or wetting agents one may sometimes detect organic matter by shaking up the solution in a flask and watching the froth that forms on the surface. If a solution froths more than usual and if froth takes some time to disperse, this may give a clue to the presence of organic material. Another method is to titrate the solution with decinormal permanganate. Where such tests may give an indication, however, they do little more and at any rate they cannot be used in the modern bright plating solutions where organic material is intentionally added. These solutions

are also far more susceptible to impurities than the orginary ones.

In a research laboratory there are certain pieces of apparatus which can detect and sometimes identify organic compounds. Most of these, however, will not indicate what the compound is, much less how it got there, but one can, for example, plot absorption curves for light of various wave lengths when passed through the solution and compare the curves obtained with the substances which have been intentionally added. In this way it can be ascertained whether other substances are present which do not correspond to those that should be present. The process is, however, lengthy and difficult to carry out and is not suitable for the control of shop solutions.

One has therefore to fall back somewhat on what may be termed organized guess work. Careful examination of the deposit produced and if necessary a metallurgical examination of a section is necessary and, by experience the trouble can usually be diagnosed as metallic or organic, or both.

Having checked all the general physical conditions, that is to say temperature, current density, agitation, etc., and having made certain that the trouble is not due to the preparation of the article before plating, the next step is to treat the solution to remove the suspected impurities. If this produces the desired result it is safe in assuming that the original guess was correct. If it does not do so it may merely mean that the treatment given has been insufficient to remove the trouble and the treatment may be repeated or intensified. It is, however, fairly safe to say if analysis has shown that the basic constitutents of the solution are in balance, that the working temperature is correct, that the current density is within the working range, and that the solution is free from suspended matter, then the trouble is usually due to some type of impurity and various treatments must be applied until one is found which will remove it.

When solutions have been recently made up or when large quantities of salts have been added to make them up to the desired composition they often give trouble. It should be remembered that although the salts purchased for making these solutions are prepared from commercially pure material they will normally contain a rather higher quantity of impurities than is allowed in the working solution. Thus it is standard practice to purify the solution after it is made up by filtering through activated carbon and working it out, before being put into production.

Influence of Basic Metal

Assuming that the solution is working satisfactorily and producing a satisfactory deposit on a standard article unsatisfactory deposits may still be obtained on certain articles.

The basis metal, that is the metal on which the deposit is made, is extremely important, it is in fact the foundation on which the whole structure is built and if this is faulty the deposit itself may be affected. For example, a casting may be full of small pits or blow holes. Not only will the deposit not fill up and form over these holes but often a certain amount of solution from the preparatory processes becomes trapped in them and upsets the process in the plating vat.

In some cases also the surface of the metal may be highly stressed or may have a so-called shattered layer on the surface due to bad machining, etc. This may produce non-adherent areas at which the deposit blisters or strips, it often being found on very careful examination, that a certain amount of the basis metal is still adhering to the underside of the deposit, that is to say the deposit has not actually stripped away on the metal surface on which it was made but that there was a loose surface on the metal which has pulled up with it. Thus it is sometimes found that where a vat appears to be working satisfactorily and produces good work, a particular article will not plate correctly. If this happens the article itself should immediately be suspected and examined to see whether the surface is in a satisfactory condition.

Zinc-based die castings are particularly bad from this point of view. They contain a small quantity of aluminium and if stored in damp conditions the metal surface is attacked often producing quite deep pits. These entrap the solution which tends to form blisters which may not appear until several days or even weeks after the article is plated. If a section through one of these blisters can be examined microscopically the cause can usually be detected but it is by no means an easy technique to carry out.

Different types of metal will, of course, require different preliminary treatments. Since the metal surface is the foundation on which the deposit is built it is obvious that it must be as clean and " solid " as possible. In the first instance, therefore, all extraneous matter such as grease, and oil, must be removed. After this has been done there is still usually a thin layer of oxide of the metal and it is necessary to remove this by an acid dip or some similar process.

Where a metal is being deposited on an article made of the same metal it is often possible to show that the crystals of the basis metal continue to grow into the deposit. At any rate, if the preparation process has been satisfactorily carried out, the adhesion between the two metals will be very high, of the same order as the adhesion between one part of the metal and another.

(Series to be continued)

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by SCRUTATOR

THE motor-car industry uses large quantities of industrial paints and pretreatment chemicals and details of the new finishing plant installed by the Studebaker-Packard Corporation at South Bend, Indiana[1] are therefore of considerable interest, particularly as it includes a new approach to the prevention of corrosion on normally inaccessible areas. The factory is the oldest sizeable plant used for production in the American automotive industry to-day and some 1½ million dollars has been invested in the new metal-finishing equipment to provide a finishing line claimed to be one of the fastest in the American motor industry. Eight different body styles are involved and colour specifications may be different on successive cars, but by a combination of automation and mechanical aids all finishing is performed on a single line — which becomes dual for increased production purposes only in its critical later stages.

Sheet-metal parts comprising those that (a) require special protection against corrosion and (b) those that are difficult to paint or inaccessible after incorporation in the body-shell assembly, *i.e.* lapover seams and other parts to be welded, receive special treatment. After a preliminary sanding, the parts are placed on an overhead monorail conveyor, cleaned and phosphated using an iron phosphate process (coating weight 50 mg. per sq. ft.), cold-water rinsed, hot chromic-acid rinsed and dried. The parts which will be concealed after assembly are then coated with an aluminium weld-through primer. It is claimed that by rustproofing in this manner prior to welding operations to join various components to the body shell, the joints are fully protected. This new system for the application of the aluminium weld-through primer is the company's answer to the problem of rust corrosion on rocker panels and other underneath fender parts.

After assembly, the body shells are given an orthodox 6-stage cleaning/zinc phosphate treatment followed by a final deionized water rinse. A 'cold' phosphating system is utilized and at current production costs steam savings are about 50 dollars per day compared with the hot process previously employed.

The painting system is described in some detail and includes the electrostatic spraying of two successive coats of alkyd primer with no 'slipper dip' as usually employed in this country after spray phosphating. There have been many approaches to this question of corrosion on the inaccessible areas of motor-car bodies and it will be interesting to see just how effective this answer proves to be.

Similarly, finishing is an important factor on motor-car 'trim' where aluminium is rapidly becoming a serious competitor to nickel-chromium plating. The Eaton Mfg. Co. has recently converted part of its stamping division in Cleveland, Ohio, from chromium plated steel to bright anodized aluminium and details have been given[2] of the forming, cleaning, chemical polishing, anodizing and sealing procedures employed on aluminium automobile trim.

Electroplating

The above reference to aluminium trim leads naturally to considerations of the present status of decorative nickel-chromium coatings and Blum[3] has recently made an authoritative survey of this subject. After critically analyzing 62 papers and articles, he has reached several important conclusions, some of the more significant of which are as follows :—

1. CASS and Corrodkote tests give good but not perfect correlation with outdoor exposure tests and service performance.
2. Sulphur dioxide tests serve principally to evaluate continuity of the chromium layer.
3. Accelerated and static exposure tests on composite coatings of copper followed by Watts nickel on steel are usually less protective than all-nickel coatings of a similar total thickness.
4. Organic types of bright nickel coatings containing sulphur do not usually give as good a corrosion protection as buffed Watts nickel.
5. Duplex nickel (semi-bright plus bright coatings) give better protection on steel and die-castings than the same total thickness of bright nickel and almost the same protection as Watts nickel.
6. Micro-cracked chromium coatings show improved performance in CASS tests although with some loss of lustre.

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Overseas Review

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7. Crack-free chromium 0.03 mil. thick is usually better than ' regular chromium ' 0.05 mil. thick.

Turning to the plating of aluminium, Faust and his associates[4] at the Battelle Institute have released some details of the ' Duramir ' process for the direct electrodeposition of chromium on aluminium using fluctuating d.c. Based on the chromium hydride theory of Snavely, smooth semi-bright deposits of good adhesion are produced which can be buffed to full brilliance in 10 to 18 seconds. The process which uses d.c. of a nature hitherto considered unsuitable for practical plating involves two preliminary dips in solutions whose compositions are not disclosed. This is followed by plating under the following conditions :—

Chromic acid 27 oz. per gallon, sulphate 0.18 oz. per gallon, undisclosed additive 0.2 oz. per gallon, current density 1 to 1.5 amp. per sq. inch, temperature 140°F. and time 20 to 30 minutes.

Luminescence is the basis of a new rapid analytical method for the control of alkaline tin plating baths[5]. It is well known that a major disadvantage of alkaline tin plating baths is that in operation tetravalent tin is reduced to the bivalent state resulting in poor tin deposits. It has been discovered that this bivalent tin luminesces in sulphuric acid solution whereas the higher valency form does not. As a noticeable luminescence appears with 0.1 gm. per litre bivalent tin in the electrolyte and as the allowable concentration is 2 gm. per litre, this is a sensitive method which readily lends itself to automatic control.

Random Topics

For those experiencing trouble with the stripping of catalyzed epoxy-type paint coatings, Douglas Aircraft Company report[6] excellent results using a 30/40 oz. per gallon chromic acid solution (180 to 200°F.) followed by hot-water rinsing. It is stated to be much faster and more efficient than the acid type previously employed and does not cause hydrogen embrittlement.

To meet the demands of those who have to prepare large numbers of uniformly painted panels for corrosion tests etc., Cooks[7] has described an automatic machine called the Spraymation which sounds a boon for all paint and corrosion laboratories !

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Low-pressure Spraying

(*Continued from page* 328)

simple arithmetic it will at once be recognized that over the period of an 8-hour working day, 250 working days per year, multiplied by the number of guns in use, a welcome saving may be expected in terms of power consumed. For this calculation, 5 cubic feet of air may be assumed to demand a power consumption of 1 horsepower.

In these days of high production, the problems of holding or lowering costs and those involving personnel take an increasing amount of time. Consequently, there is little time spent in training the man who holds the spray gun. Often a supervisor will start off the operator properly, but because of the pressure of other problems he fails to check that instructions are being followed. In cases where operator training has been instituted, the finish of the product has improved, and in addition, manpower and materials have been conserved. The person in charge of such a programme must have a full knowledge of spraying equipment, the proper maintenance of the plant, know the correct spraying technique and understand material control. No plant is too small for such a programme, although the amount of time spent on this job would of course depend on the productive capacity of the plant and the number of spray operators employed. The spray operator and his method and skill in applying vitreous coatings is an important deciding factor as to whether or not the best finish is produced at the lowest possible cost. Too often a finish that is passable is accepted, and no attempt to improve upon it is made.

Spraying yesterday and spraying today is a noticeable contrast. With the advent of new materials it is a natural sequence to have new equipment and methods with which to apply them. There has been considerable progress made and the technique of using lower spraying pressures is one that has been successfully followed in the organic field, and must also be utilized to the full in the inorganic field. Such new methods are merely a systematic approach to spraying problems, and by the adoption of to-day's methods, the job of spraying has become an easier one. Greater production has resulted, fewer rejects experienced, worthwhile material economies have been effected, less wear on equipment has been shown, economies in power consumption due to savings on air are reflected, and by such savings a conservation of critical materials has been possible.

From whatever angle one considers the spraying problem, low-pressure spraying has shown economies and advantages to justify careful consideration of it on all types of production and without question once it has been tried it will be found acceptable and continued in practice.

METAL FINISHING CONFERENCE

Llandudno May 2 to 6, 1961

A Report of the Annual Conference of the Institute of Metal Finishing

(Continued from page 312, August Issue, 1961)

CALORIMETRIC DETERMINATION OF METAL COATING THICKNESSES ON SMALL OBJECTS

By G. Krijl* and J. L. Melse*

THE paper describes a test in which the reaction of a metal and a solvent whereby the metal is dissolved, produces a measurable amount of heat, depending on the system chosen (metal-solution). This amount of heat is directly proportional to the weight of the dissolved metal.

A metal-coated product, of which only the coating is dissolved, produces for a constant surface a quantity of heat which is proportional to the average coating thickness. This principle is used to determine coating thicknesses. In order to measure the generation of heat as accurately as possible, a simplified calorimeter is used.

The choice of the number of objects and the quantity of liquid is determined for each kind of measurement experimentally and will depend on the shape of the calorimeter, the shape of the objects, the average coating thickness and the heat evolved during the reaction of the metal coating with the liquid.

It is preferable to aim at a difference in temperature which is sufficiently large to give the determination its required accuracy taking into account reading errors and other errors of observation. Among other factors, it should be remembered that the greater the number of objects used per measurement, the less can be said about the coating thickness of the individual objects.

To keep the number of objects small and hence to observe the correspondingly small temperature rise, it is recommended to use a thermometer whose scale divisions are equivalent to 0.2°C. With a thermometer of this kind a temperature rise of from 2 to 3° C. is sufficient for a routine measurement in the factory.

The author concludes by saying that in view of the choice of the measuring conditions and the drawing up of the calibration line the method described is not suitable for individual measurements, and can only be useful where constantly recurring measurements have to be carried out on items which are produced over long periods of time. Since the calibration line depends on the type of calorimeter used, the quantity and kind of liquid used, and the number shape and weight of the items, the figures and graphs given in the paper are for guidance only.

*N. V. Philips Glocilampeufabviken.

DISCUSSION

MR. E. S. SPENCER-TIMMS (War Office) said that the authors' idea was not new but they did appear to have made it practical, and until suitable instruments for the non-destructive measurement of coatings on such very small-sized components were invented the test must satisfy a need in the field of thickness measurement, although it was of extremely limited application.

It gave, of course, only an average thickness but should give a true average thickness, whereas the well-known time-of-gassing test — probably the only other type which could be used with such components — tended to give the maximum thickness, as the bigger areas of plating continued to gas after the thinner parts had been stripped. This might well, of course, suit the practical plater, who would prefer to have the maximum and not the minimum thickness determined.

Unfortunately, the method only appeared suitable for quality-control tests on regular production lines for large numbers of small components and could not be used as an ordinary inspection test. It required a great deal of empirical standardization and depended upon the particular component and its surface area, whereas the time-of-gassing test was theoretically, at least, independent of the component and its area.

The authors nowhere gave direct data upon the accuracy and reproducibility of the method. What did they consider to be the overall accuracy of measurement of the average coating thickness ? It may well be better than $\pm$ 25 per cent. achieved by the time-of-gassing method, which had a large personal factor in the determination of the end of gassing. There could be no doubt about the end in the authors' calorimetric method.

No reference was made to the temperature of the specimens. Surely this was important, particularly when such very small volumes of reagent, such as 3 millilitres, were used. The temperature rise would be proportionate to this volume of

liquid. How, therefore, was this small quantity to be accurately measured without laboratory equipment — at least a pipette or a burette ?

In the paper the authors gave the temperature rise for ten springs tested simultaneously as 5 or 6°C, whereas the curve in Fig. 2 showed temperature rises of the order of 20 to 25°C. He assumed these referred to different thicknesses of coating. The test was claimed to be rapid, but, according to the coating, it seemed to require 3 to 10 min. per test, which must limit the number of tests an hour that one could carry out without a great multiplicity of calorimeters.

Had the authors considered employing a more sensitive method of temperature measurement, *e.g.*, a multi-thermocouple junction ?

MR. E. A. OLLARD (Atlas Plating Works) said that it seemed to him that practically all the deposits that were likely to be tested would have in them a good deal of internal stress of some sort or another. It would not be a constant factor, even for a particular solution — at any rate over a short period — because most platers knew that solutions tended to vary somewhat in work, and that the internal stress in the deposit could sometimes go up or down a good deal. Was this likely to produce a significant difference in the results ?

Had any trouble resulted from exposure of the stem of the thermometer ? As he recalled it, one had to make all sorts of allowances for thermometers, especially where stem exposure was involved. The apparatus seemed to have a very big stem. Were the temperature measurements as accurate as one could get ? He did not think there was any great disadvantage in having to test ten specimens at once because, in this type of work, that was usually a very satisfactory statistical number for a batch.

Effect of Brighteners

MR. M. J. REIDT (Metal Research Institute, T.N.O., Holland) sought information on the effect of different brighteners on the reaction time, and thus the coating thickness. What was the average preparation time of the calibration curve, especially for zinc and cadmium ?

MR. M. CLARKE (Tin Research Institute) referring to the effect of internal stress in the deposit, said that he had made some calculations recently to ascertain whether he could determine stress either from the energy released in the way Mr. Ollard had described, or from a change in the electropotential of a stressed deposit, compared with the same deposit unstressed. He had found as a result of the calculation — one similar to which had recently appeared in the Journal of the Electrochemical Society — that the change of energy produced by the stress in the deposit was of such a very small order with the chemical energy of dissolution of, say, a nickel, that it was impossible to measure it.

Authors' Reply

MR. J. L. MELSE, replying, said that it was interesting that such a high degree of accuracy could be obtained on such a simple apparatus. In the case of zinc on steel they had had an accuracy of 2 per cent. under laboratory conditions. In the case of the nickel plated test springs in the factory the accuracy was 4 per cent. They favoured a simple apparatus and therefore used an ordinary temperature thermometer and measured the liquid in an ordinary measuring cylinder. They had filled this by means of a polythene bottle or tube, and in this manner it was possible to have an accuracy in the amount of liquid of 0.07 millilitres. The accuracy measurement for zinc and nickel on steel had been assessed statistically from 20 determinations. For higher accuracies it was possible to use better thermometers, a better temperature recording apparatus and a burette. It might produce a temperature range so small as to make possible the use of the apparatus with individual articles, but they had no experience of this. They had used the apparatus for more than a year, with good results, in their factory.

Two temperature rises had been given, but one could not speak of temperature without mentioning the scale division of one's thermometer. In the first case they had used a thermometer with a scale division of 1° and in the second one with a scale division of 0.2°. This accounted for the somewhat confusing statement.

It was necessary that the temperature before the first reading be constant, because it had a great influence on the results. The first time they had used the apparatus in the factory the results had not been as good as later, when this fact had been realized. The liquid stood in one corner of the room and the apparatus in the other. Therefore there had been a difference between the temperatures. The liquid and apparatus now stood in the same place. Also, the practice was to wait a few minutes before dropping the article in to ensure that the temperature was that of the liquid and the apparatus.

The kind of nickel and zinc used had a remarkable influence on the dissolution rate, but not on the amount of heat. The reaction rate was influenced by the addition agent in the nickel, cadmium or zinc bath. In the time-of-gassing test this was a drawback, but in the present test one waited until the reaction was complete. In the case of bright nickel the reaction was complete in ½ min. and in the case of matt nickel 1 min. They waited three minutes and thus were sure that the reaction was complete. They then measured the temperature. There were always heat

losses, but the metal had no influence upon the accuracy of the apparatus.

For a normal calibration line they made five or six determinations. This took perhaps an hour and a half. They had only to make a few determinations because the accuracy of the determinations was high.

DR. S. WERNICK said that the authors had described an ingenious method of determining thickness, underlining the fact that it had particular relation to exceptionally small objects. On the principle " that the proof of the pudding was in the eating," they had operated the method very well indeed in both the laboratory and the factory and it could be accepted as a most interesting technique for determining thickness on a routine basis.

ONE-YEAR EXPOSURE TESTS ON ANODIZED ALUMINIUM

by J. A. Whittaker* and J. M. Kape†

THE purpose of this work is primarily to determine the protective value of sulphuric-acid anodizing of various film thicknesses on a variety of alloys. The results of one-year's exposure tests on twelve sheet alloys each with five anodic film thicknesses are therefore described. Five extruded alloys are also included. The specimens were exposed at the BISRA site at Stratford, East London and at an Admiralty site on Horsea Island, Portsmouth. Further collections are planned provisionally for four and eight years.

The results reported in the paper show that the resistance of the anodized material increases as the thickness of the anodized film increases, and that the anodic film thickness which is necessary to give complete protection depends upon the alloy, whether the metal is freely exposed or sheltered and particularly on the site.

The high-purity alloys such as super purity, SP-1Mg and S1A maintain, even with relatively thin films, 0.5 mil. or less, a good appearance after one-year's exposure to a severe industrial atmosphere. The appearance of the unbrightened alloys S1C, NS3 and NS4 with films of less than about 0.5 mil, is markedly affected by pitting. H10 and H20 need a much thicker film, approximately 1 mil, than any of these other alloys to withstand a year's exposure to industrial atmospheres.

The clad H15 materials developed a much worse appearance than the unclad material after a year's exposure, although metallographic examination of the former shows that the putting had spread over the surface and had not penetrated the cladding. The increased corrosion resistance of the hard anodized coating as compared with an equivalent thickness of normal anodizing is noteworthy. Of the extruded alloys, the behaviour of HE9 was outstandingly good.

Intermediate cleaning after six-months exposure did not cause any improvement in the life, but this may not be true for thicker coatings under conditions where the period before commencement of pitting is longer than a year. This should emerge during longer exposure.

The worst of the aluminium-alloy specimens behaved very much better than chromium plated steel and most of the anodized samples appeared superior to stainless iron.

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DISCUSSION

DR. F. A. CHAMPION (British Aluminium Co. Ltd.) said that it would be generally agreed that the important impurities in the metal, from the point of view of anodizing, were iron and copper. The S1A metal did, in fact, exceed the British Standard for iron content and therefore could not be regarded as typical of that specification. So far as the purities S1A, S1B and S1C were concerned, the British Standard specification laid down maximum copper contents of 0.02, 0.05 and 0.1 respectively, whereas all three of the metals contained 0.01. Here again one could not regard them as meeting the specification.

Turning to the film thickness, he had been surprised at the lack of correlation between the measurements by the eddy-current meter and the chemical stripping method. As an illustration of this he would quote some recent determinations on sulphuric acid film. He obtained agreement to within $\pm$ 0.02 and, as could be seen, good agreement had been attained. He felt that the lack of agreement shown in the paper was on the side of the meter rather than of the chemical stripping method. Thus, it was unfortunate that the authors had chosen the meter figures for the comparison with the performance data. On the anodizing aspect they had used a temperature of 80° C on the high-purity — super-purity base metal. He would regard 90° C as more suitable. Also, he had been surprised that although the specimens had been waxed the authors did not regard this as making a significant contribution to corrosion resistance.

He had not found the detailed results very helpful, and it was necessary to rely on the authors' opinion, having seen the actual specimens. Comparing Figs. 1 and 2 it became evident that the reflectivity was retained to a much better extent on the higher-purity material in Fig. 1. Both were significantly better than the ferrous materials shown in Fig. 7, especially if one took into account the fact that this related to much less severe exposure conditions.

Regarding Table V, in which the authors had

attempted to collect the minimum film thicknesses necessary for the avoidance of pitting or attack, the spacing between the successive increases in thickness varied from metal to metal. This made the figures less informative than would appear at first sight. It was stated that the condition of the H15 alloy was not known. He would suggest that before another paper was presented the mechanical properties be determined in order that information could be provided on the point.

MR. T. M. KETTERIDGE (Ionic Plating Co. Ltd.) said that he had noticed considerable variation in the current density at which the anodic film was produced and wondered how much effect this had on the final results of the corrosion tests. One very important field in anodizing at the moment was the production of a very thin anodic film on brightened materials, especially for use in the car industry. He would like the authors' opinions on the manner in which this film was produced. As they had shown in their work, the thin film was in itself a very poor protective. However, if produced under different conditions the protection it offered from corrosion could be considerably increased. This view was supported by the view that the authors' hard anodized sample had very good corrosion resistance.

Marine Atmospheres

It was interesting to note that there was improved corrosion resistance in the marine atmosphere. This pointed to what one might almost call the uselessness of salt-spray tests for corrosion resistance after anodizing. In the car industry it would be useful when the roads were salted for bad weather protection.

One very worrying feature of the material was the bloom, which was very often passed over somewhat lightly. It was quite a serious problem in decorative trim, and once present was not easily removed. Did the authors feel that this could be partly prevented by improved anodising conditions ?

Curtain Walling

MR. F. C. PORTER (Aluminium Development Association) said that the paper had indicated that in a very highly polluted atmosphere, such as Stratford, a 25-micron 0.001-in. film on alloys used for curtain-wall construction was likely to have a limited life. Nevertheless, this was the film given in BS 1615. As many present would know, a draft revision of this standard was now circulating for industrial comment and in it a thicker grade, of 35 microns, was recommended for use in architectural applications in aggressive environments. This compared with 20 microns, used in many Continental countries, and America. Once again, it showed how much more aggressive and corrosive were British atmospheres. What increase in life was a 35 micron film likely to give over a 25 micron film ? One would imagine that if corrosion were by hemispherical pitting, one would get increased life to a factor of 3, but he would suspect that the mode of failure was not of this nature and might well be more associated with defects in the anodic film. The latter would seem to account more readily for the fact that the authors had had fewer pits on thick anodic films than on thin. If the pits had been of the hemispherical type it would have been difficult to account for this factor, on the assumption that the anodic film, being an insulator, could not readily provide cathodes.

The difference between hard anodizing and anodizing at room temperature on H15 was important. Was this due to differences in composition of the anodic film or possible defects of the structure ? The edge effect on the clad H15 was interesting. Was this due to there being a thin anodic film at the edge of the clad specimen, or was there a cathodic protection of the unclad edge occurring during service. The 1 per cent. magnesium alloy based on the 99.7 alloy used in the tests was actually from a development batch, not a production batch, and this might account for the unusual behaviour of the undersides of the specimens at Stratford, where circular rings of corrosion were found. He had not seen this type of corrosion as a result of service, though hundreds of thousands of radiator grilles of this type of material were now in use.

" NG21 " was referred to in the paper. The British Standards Specification 1470-77 used G in referring to wires and it would probably be more correct to refer to the aluminium 1-5 per cent. silicon alloy widely used for architectural applications as " N21." HS10 material was more appropriately described as " HS30 " as the manganese content was 0.41 per cent.

MR. R. J. BROWN (British Motor Corporation) said that one of the alloys mentioned, which the author had defined as SP-1Mg was, he believed, basically the S1A alloy in the appropriate British Standard. The British Standard defined the purity of the alloys in a fictitious manner. There was super-purity, defined as S1 99.99, and this meant what it said. Then one went to the succeeding alloys, in respect of which the title did not mean what it said. In the 99.8 purity was as low as 99.67 and users found it extremely difficult to convey exactly what was meant. They had had approaches from the aluminium industry in which it was suggested that one should specify 99.8 purity when 99.7 was acceptable. As a technical man he believed that 99.8 purity meant exactly that ; there should not be an excess of 0.2 per

cent. impurity. He appealed to the aluminium industry to give more definite guidance in such matters.

Influence of Waxing

He, too, wanted to refer to the possible influence of waxing because, with electrodeposits, it had a very pronounced effect. The waxing of a sub-standard plating deposit would raise its performance appreciably. It would have been far better if the authors had used an exposure panel which conformed to British Standard and, as it was on a steel base, one of the more modern deposits, such as dual nickel.

The influence of the thickness of the anodic film on corrosion resistance had always been accepted, but when one was using an anodic film or anodized aluminium for a trim, such as that on a motor car, the important thing was the maximum thickness that one could manage without impairing the appearance of the product.

In SIA, iron content was limited to 0.15. From time to time representatives of the aluminium industry suggested that 0.15 was too high a figure for brightened and anodized aluminium. One was interested in performance and appearance rather than composition but one had to lay down requirements here in order to control the people manufacturing the components. He would like to see some further work on exposure tests related to the influence of impurities.

Dr. T. P. Hoar (University of Cambridge) said that the authors had dealt in a rather offhand manner with the effect of waxing, regarding it as having an insignificant effect on corrosion resistance. Such an assumption should not have been made, but if it were, what had prompted the authors to wax at all ? Sealing had in this paper, as in others, been treated rather casually. A paper was at present being published which showed that sealing was by no means perfect on 20 or 30 examples used commercially. It closed up the pores to the extent of 98 or 99 per cent. of film, but if one went on sealing for 24 hours, the actual electrolytic resistance of any electrolyte in the pores increased between 4 and 20 times. Consequently, the subsequent corrosion resistance of aluminium and what he might call super-sealed aluminium — sealed for 24 hours — may be very different. Had the authors any information as to whether a very high degree of sealing, producing this great increase in resistance of the pores, had any beneficial result under their conditions ? Experiments at Cambridge had shown that the thicker films gave a very much more resistant film from the electrolytic point of view and he was interested to see that this was true also from the corrosion point of view.

Authors' Reply

Mr. J. M. Kape, replying, said that the effect of impurities and of iron content was very much in their minds, especially the fact that the latter was extremely important. Some work, as yet unpublished, had been done showing that anodic coating breakdown, at least on thin films with bright anodized aluminium might be associated with the presence of iron or iron-constituent particles. In regard to the composition of the alloys relative to the British Standard, he could only say that the results in the paper were given by spectrographic analysis which was not, of course, as accurate as a wet analysis. Possibly in future work they would report the results of further exposure and would get round to further analysis of the alloys used. The eddy current measurements had been taken with a proprietary instrument. The manufacturers said that this was accurate to within 0.05 mil. which was considerably less than the accuracy claimed by Dr. Champion for his instrument.

Waxing had been undertaken because so many people in the anodizing trade followed this practice. He felt that in many cases it was done to try to disguise the effect of bad sealing. Sealing was not ways carried out under the conditions reported in the paper, namely at 100°C. for thirty minutes and the correct *p*H. More often than not sealing was done at a temperature of 90°C. and the *p*H might not necessarily be constant. Subsequently, the work would not handle easily and was subject to finger marking. Waxing got over this and they had felt that, at least on some of the bright anodized trim samples, they should apply wax. Work since that time had supported the belief that waxing was not a good idea. It could cause a build up of soot and grime very close to the surface and even promote premature breakdown in the anodic film. Unless wax was considered a temporary protective and removed on site afterwards, they did not recommend it. There was no harm, of course, in waxing bright trim components of motorcars in service.

He made no apology for their method of assessment. He would agree that the visual method was perhaps the best when one was considering corrosion of this type, as it was a somewhat random process. They would certainly determine the mechanical qualities of H15 in order to ascertain its condition.

A good deal of work had been done on current density and manner of anodizing, but it did not seem to add up very well; for example, for some years earlier people had advocated low electrolyte concentrations and low temperatures with high current densities for anodizing. This had since been proved useless for bright trim because high current density destroyed the reflectivity by causing

an orange-peel effect on the surface. Recently the Americans had gone to the other extreme and decided to have a concentrated electrolyte, high temperature and low current densities. It seemed from other work that they were in fact right, that the higher the electrolyte temperature and, within limits, the concentration of the electrolyte, the better the results from the brightness and possibly the corrosion point of view.

They would agree with Mr. Ketteridge's comment on the effectiveness of saltspray tests for anodized aluminium. They did not think there was any justification, for example, for putting a piece of anodized material in a saltspray cabinet, giving it so many hours then saying that it had a certain number of pits and would do so and so in the air. They did not think there was any point in putting acetic acid and copper in with the salt because one began to get copper deposit on the metal and subsequent galvanic corrosion, which produced an effect rather like that one got on pots and pans when using copper-contaminated water. This was not commensurate with outdoor exposure.

He had no idea what the life of a 35 micron coating would be. One could only assume that such a coating would last much longer than a 25 micron coating. They had been asked to comment on the mechanism of breakdown in anodic coatings. Certainly so far as the super-purity type metals were concerned, it was definitely associated with iron or iron inter-metallic particles. As far as the other alloys were concerned, the mechanism must be related to a defect in the anodic film, through which the electrolyte passed, starting corrosion underneath the barrier layer. This crept out longitudinally and eventually the anodic film caved in to the hole that was left. They had done a few microscopic examinations and this appeared to be the mechanism.

The drawbacks of hard anodizing, so far as architectural and motor-car applications were concerned, might be put down as cost and the fact that although one had a hard film there was as yet no evidence to suppose that on the range of alloys tested, especially the high-purity types, it would prove more corrosion resistant.

They had had no choice in the standard of plating used. They had sent the specimens to a plater with a request that he put on the required thicknesses as they proposed doing some exposure tests but had got back the plating described.

MR. J. A. WHITTAKER, replying further, agreed that the work should not stop at the present point, and that the most important element was the sealing. This should be allied, he said, with the method offered by Hoar and Wood at the previous year's conference. So far as relative atmospheres were concerned they proposed to publish shortly, through the Institute of Metals, a description of eight-year tests in this country on two aluminium alloys and a comparison with 20-year figures from the A.S.T.M. Therein lay their justification for saying that the atmospheric conditions were worse than in the United States.

THE SELECTION OF FINISHES FOR COMMUNICATION EQUIPMENT

by W. Marchand*

THE factors, governing the selection of a finish are discussed in the paper, and the properties of the available material considered in relation to them. The constructional materials are steel, copper alloys and aluminium alloys, and treatments to give protection while retaining other properties include electroplating, metal spraying, chemical treatment and organic finishing.

Very often, finishes have to meet special electrical and magnetic requirements. In the case of relays, magnetic iron parts are usually finished with nickel. Where tropical conditions have to be met, a nickel-plus-chromium finish is preferred. On the radio side, where high-frequency conditions very often apply, silver is most commonly used as the finish, either on copper-containing alloys or on aluminium. This often entails plating complex waveguides, where special precautions have to be taken. The shapes are such that internal electrodes are required, and preferably separate current control on the internal electrode and external anode circuits to enable the current density to be accurately controlled to give the correct thickness of silver on the inside and outside surfaces.

Great care must be taken to avoid the use of silver on components which are separated by a solid insulator and subjected to a d.c. potential, as silver migration will occur between the two components, particularly under humid conditions. Where these conditions apply, gold may often be used as the alternative finish.

It is also very often a requirement that all the parts making up a cubicle assembly are electrically bonded, one with another, for screening purposes. In the case of aluminium fabrications which are subsequently enamelled for appearance and protective reasons areas may be masked to provide contact.

Where ferrous metals are used, the problem is more difficult, as unpainted areas will obviously rust. Under these conditions small components may be cadmium plated and passivated before masking and enamelling and larger components can be aluminium sprayed. In certain special instances, plastic materials may be required with a conducting surface, and in this case shot blasting, followed by copper spraying, may be used.

* Standard Telephones and Cables Ltd.

On costing, the author states that finishing systems are constantly being explored so that costs may be kept to a minimum. Hammer enamels have proved beneficial in providing a finish which tends to mask imperfections in the base metal, thereby saving filling and flatting operations.

Costs may also be kept to a minimum by ensuring that work requiring enamelling does not involve masking. This may involve changing the design from assembly after finishing, so that two components, each requiring a different finish, may be treated separately instead of the assembly being partly finished by one system followed by masking and finishing by a second system.

The paper is then concluded by a discussion on modern trends, in which mention is made of printed circuits, miniturization with the increased hazard from whisker growth and magnetic drums as memory devices.

DISCUSSION

MR. J. DE RUDDER (Belgium) said that it was important to educate both the designer and the plater. On the one hand, they must know the techniques employed and, on the other, keep in mind the fact that faults in design were always costly. Another important aspect was reliability. Were the authors satisfied about the relation between the accelerated tests and the behaviour of the components in service ? In his opinion, too much confidence in accelerated tests could be harmful in some applications. It had been said that corrosion of cadmium by organic vapour could occur. Phthalic acid and its anhydrides were corrosive. Could Mr. Marchand give some details concerning the other organic material which gave trouble ?

On the question of silver deposits on aluminium, had he observed any differences in corrosive resistance if zinc, iron or nickel were deposited first ? He had spoken of the migration of silver. What were the minimum conditions necessary to realize this phenomena ? On the use of gold as a contact material, did he think that pure gold was better than alloys ? Experience in Belgium confirmed the fact that gold deposits must be carefully rinsed after plating. Had the author any opinion to offer on the mechanism of corrosion when post-treatment was not carried out ?

In regard to the magnetism of nickel, could he give any details of the differences between the Watts nickel and the sulphamic bath, in particular the conditions of deposition which gave rise to the desirable magnetic properties in the nickel deposits ? Did the phenomenon of whisker growth occur with the tin-lead deposits ?

Sprayed Aluminium Coatings

MR. F. C. PORTER (Aluminium Development Association) asked the author to enlarge on his comment that iron and steel structures subjected to outdoor conditions were usually finished with a sprayed aluminium coating. Was this a factual observation, or a policy adopted on the basis of either test or experience ? It was a very controversial subject nowadays with zinc, zinc-aluminium, and aluminium coatings vying for the trade. He had rightly paid much attention to the danger of bimetallic connections, which were important, but was much trouble experienced with stainless steel screws in aluminium-alloy assemblies ? In his own experience, this was rare, particularly when the area ratios were so favourable — a large aluminium area and a small stainless-steel area. Although the potential difference was quite large, the oxide films on the two metals tended to make the passage of corrosive currents more difficult. On the other hand, with copper and aluminium the use of tin or nickel on the copper was probably beneficial in preventing copper dissolving and spreading over the surface of the aluminium to set up serious corrosion there.

He had mentioned the use of blasting followed by an aluminium-pigmented lacquer to overcome the problem of poor appearance. Had he made much use of the patterned aluminium finishes that were available on aluminium sheets ?

Palladium Plating

MR. F. H. REID (Int. Nickel Co. (Mond) Ltd.) expressed surprise at the absence of any reference in the paper to palladium plating, particularly in relation to the finishing of printed circuit end-connectors. He said that one of the most outstanding features of plating during the last few years had been the increasing interest in palladium as an alternative to gold or rhodium in this application.

MR. G. SCHOFIELD (Ministry of Aviation) referred to corrosion of cadmium plating by organic vapours. On the aircraft side defect reports had been made concerning this type of corrosion in equipment. It had been found to be due to phenol-formaldehyde resin materials in close proximity to cadmium-plated items in containers, confined spaces, or even wooden packing cases. Trouble had been experienced with paints and insulating varnishes, adhesives, plastic mouldings and even film-bonded plywood where these materials were based on phenol/formaldehyde resins, which, if slightly undercured, gave off vapours adversely affecting the cadmium plating. The plated parts developed extensive white crystalline growth. The remedy adopted

was to provide adequate ventilation to such containers or allow sufficient time for the disposal of vapours before the assembly of equipment.

Whisker Growth

MR. S. C. BRITTON (Tin Research Institute) said that, on the question of whisker growth, he only wished that he could tell Mr. Marchand how to avoid it with tin always, but in the particular instance selected he could be a little helpful. He referred to the growth that occurred in bright tin coatings on brass ; this was a double type of whisker, a type which was rather like worm casts, shapeless but very persistent, and the normal form of filamentary whisker. The shapeless worm cast type seemed to be caused by zinc coming through the deposit from brass. The normal filamentary type were tin whiskers. It so happened that bright tin was very susceptible to zinc diffusion from brass, much more so than other forms of electrodeposited tin. It was possible to suppress this special form of growth by a barrier layer on the brass. In fact, there was some evidence that whisker growth on bright tin, over a steel surface, was much less likely than on some other tin deposits. In general, one could say that the diffusion of zinc into tin deposits from brass was a stimulant of whisker growth.

Some years earlier it had been put about that deposits of tin on brass were much less prone to whisker growth than were deposits on steel. The experiments in question had been based on electroplated brass, and those concerned would probably agree now that they had obtained a wrong result. It could do no harm, perhaps a great deal of good, to have always a barrier layer between the tin and brass, both from the point of view of growth and the other effects of zinc diffusion to which Mr. Marshand had referred.

Whisker growth was extraordinarily difficult to study. It was not easy to gain experience or reproduce effects from one year to another. However, would the author confirm his suggestion that there was a greater liability to growth on deposits over brass where a barrier layer was absent, or in comparison with steel ? What had been his experience with coatings of tin that had been melted ? There seemed a much lesser tendency to growth on these as compared with straight electrodeposits.

Author's Reply

MR. W. MARCHAND, replying, said that he agreed that people should be educated to think of finishes at the beginning of a development rather than the end, or not at all. In general, accelerated tests were used to satisfy specification requirements, as a control on production where one knew what should or should not happen under a given set of conditions, and also as a guide.

There were many organic vapours. One of the troubles had been wooden packing cases of an unsuitable type, and acetic acid vapour corrosion. In regard to silver on aluminium, they had not really any experience in the use of nickel or iron pretreatments. They used, exclusively, the zinc pre-treatment followed by copper and silver. This was quite satisfactory provided thickness was kept to at least 0.002 in. and no one drilled holes in it on assembly after finishing.

He would not care to define minimum conditions for silver migration. All the experience that they had had suggested that, given two silver-plated conductors on an insulator, and an a.c. potential, irrespective of the insulating medium one tended to get silver migration under certain degrees of humidity — the higher the humidity the greater the migration.

There was a danger in using silver-plated components separated by a solid insulator with a d.c. potential under dry conditions. An air conditioning system might fail so that humidity would rise rapidly. It would not then be long before serious silver migration would occur. Rectification would be a very expensive business.

In regard to the use of gold as a contact impurity, they were, with a lot of other people these days, in view of the many gold solutions now available, investigating various gold deposits. They had found that in the case of a transmitter head set where one used a brass cup copper and gold plated, then filled with carbon granules, that pure gold was very important. Certainly, if one had the odd 1 per cent. of silver there it appeared to affect the performance of the transmitter electrically.

They had adopted demineralized water washing but had found that this alone was not satisfactory. It had been necessary to precede it by a dilute alkali followed by a dilute acid wash. This had a remarkable effect on the performance of the gold and reduced the burning figure considerably. The question of hysteresis loops was very complex, as anyone who had anything to do with memory drums knew. He could not give at the moment the exact conditions of the plating involved. Mr. Marchand then illustrated a hysteresis loop of a nickel deposit plated from a normal Watts bath under normal conditions in which the B.R. was rather low ; also a similar loop from a nickel deposit plated from a nickel sulphamate bath under normal conditions, pointing out that it had a far higher B.R. and a far greater area under the loop.

In regard to whisker growth on tin-lead, he said that anyone who had read the various Bell laboratory reports would know that under certain conditions it seemed possible to grow whiskers on

(*Continued in page* 348)

ELECTRODEPOSITION OF METALS FROM NONAQUEOUS MEDIA

Some Notes on a U.S. National Bureau of Standards Investigation

THE U.S. National Bureau of Standards electrodeposition laboratory has recently conducted fundamental investigations into reactions occurring when a direct current is passing through organic solutions under relatively anhydrous conditions, in order to obtain basic data on electrode reactions while metals are electrodeposited from nonaqueous organic baths.

The investigated products were formed by electrolysis of formamides, acetamides, and propionamides, and are assigned to one of two general classes—bis-amides of methane ($C_nH_{2n}N_2O_2$) or bis-amides of methyl-ether ($C_nH_{2n}N_2O_3$).

Low-molecular-weight amides, which are stable organic materials, slightly conduct the electric current. Like water, they dissolve inorganic salts to form solutions which are more conductive. Products resulting from the electrolysis of simple amides are stable and consequently do not decompose into tarry substances as many organic compounds do.

The electrolysis of the N-methyl amides and of the N-N-dimethyl-amides was performed in glass test tubes placed in a water bath to maintain temperature at about 35°C. The electrodes, which received current from a 110-volt d.c. line, were of bright platinum spaced about 1 cm. apart in the test tube.

Because solvents of higher molecular weight are poor electrical conductors, dilute sulphuric acid was added to some of the solutions in an attempt to decrease the electrical resistance. Resulting data showed that even limited amounts of dilute sulphuric acid caused a different reaction at the electrodes in some of these solutions.

Electrolysis of the amides does not produce a single compound. In all cases where solid products were isolated, liquid products also formed. The amides are not reduced to their respective amines as expected, but produce condensation products containing two or more molecules of the starting material. Also, there occurs partial decomposition of the starting material. This finding is supported by the fact that nitrogen was found in the cathode gases during the electrolysis of N-N-dimethylformamide and that the final product contained three atoms of oxygen and two of nitrogen.

Analysis of the products indicated that it is the groups or atoms attached to the nitrogen that enter into the electrolytic reaction, and that the methyl groups are more susceptible to electrolytic change than is hydrogen when both are attached to the same nitrogen atom.

To establish the exact structure of the products, known derivatives of these products were synthesized. First the various products were hydrolyzed with sodium hydroxide into an amine and a salt of an acid. Then the sodium salt of the acids and the hydrochloride salt of the amines were used to prepare the derivatives, which were identified by melting point and other physical properties. Infra-red spectra were utilized to determine the presence of secondary and tertiary amides. In all cases except one—N-methylformamide—the alkaline hydrolysis produced two moles of amine and two moles of acid per mole of compound hydrolyzed.

A mixture of formamide and acetamide was electrolyzed to determine whether formamide can be used as a solvent for the electrolysis of acetamide and to determine the relative stability of the two compounds. The experiment showed that formamide is more easily changed by electrolytic action than is acetamide because most of the electrolysis products were formed from the formamide.

As an application of this research, formamide was used to prepare a zinc bath from which zinc was successfully plated on a metal surface. The anhydrous, organic bath contained zinc acetate, potassium acetate, and formamide. Coatings of zinc as much as 0.008 in. thick can be smoothly deposited.

Reference

The Electrolysis of formamides, acetamides, and propionamides, by D. E. Couch, *J. Electrochem. Soc.* (in press).

COATED TITANIUM ANODES

IMPERIAL Chemical Industries Ltd., Magneto-Chemie N.V., Schiedam, Holland and The Amalgamated Curacao Patents Co. of Curacao have agreed to pool their appropriate patents and collaborate to develop and extent the use of titanium anodes coated with an extremely thin film of platinum or similar metal.

For some years these firms have been separately engaged in developing coated titanium anodes and independently found that potentially they offered very considerable advantages over conventional materials in industrial electrolytic cells for chemical manufacture, electroplating plant and equipment for converting brine to drinking water.

The Metals Division of I.C.I. are marketing platinized titanium anodes which are being manufactured in Great Britain by their subsidiary, Marston Excelsior Ltd. of Wolverhampton.

"The Use of GALVANIZED STRIP IN AUTOMOBILE MANUFACTURE IN THE UNITED STATES"*

TWO representatives of the zinc industry recently visited the United States to obtain the most up-to-date information on materials and techniques employed in the use of zinc-coated steel strip.

Zinc-coated steel has been used for motor cars in America for many years, but recently owing to the effect of corrosion on the strength as well as on the appearance of motor cars, the American automobile industry has been forced to use more corrosion-resistant materials in critical areas of the main body and underbody assemblies. So far only zinc coatings have provided the required combination of properties with respect to forming, spot welding and finishing. In addition to the marked growth in demand for zinc-coated sheet, both hot-galvanized and electro-coated sheet, it is estimated that approximately 9000 tons of zinc dust were used by the automobile industry in 1960.

Growth of continuous galvanizing lines in the U.S.A. has been rapid and at the end of 1960 there were 37 working lines, owned by 12 organizations. A further two lines were under construction and scheduled for production this year.

Production of Galvanized Strip

Initially, sheet with a differential zinc coating was required in order to minimize spot-welding difficulties. Advances in spot welding, have, however, resulted in a growing demand for uniformly coated sheet possessing a minimized spangle and a normal coating weight of $1\frac{1}{4}$ oz. per sq. ft. While some differentially coated sheet was still being supplied. it is anticipated that demand for this product will cease in the near future.

The need for smoother finishes by reducing the spangle has been achieved by spraying both sides of the strip with steam shortly after its exit from the zinc bath. The type and size of jet used was important and also the degree of saturation of the steam. Further refinement to finish was obtained by giving the product a final skin pass through grit-blasted rolls, the sheet undergoing between $\frac{1}{2}$ to 1 per cent reduction.

While the standard quality sheet ($1\frac{1}{4}$ oz. per sq. ft.) is the predominant requirement, there is undoubtedly a trend towards tighter specifications and hence closer control over coating thickness. A minimum coating weight of 0.45 oz. per sq. ft. per side as measured by the triple spot test and 0.40 oz. per sq. ft. per side by a single spot test has been requested in some cases, The normal maximum variations in coating thickness (± 10 per cent variation on either side and ± 20 per cent from front to rear) have had no significant effect on the welding or forming operations.

Automobile Manufacture

At the present time special grades of hot galvanized strip are the materials most commonly used for corrosion-prone parts of the underbody assemblies. Where skin panels are coated they are usually coated on one side only by spray painting with zinc-rich paints. Problems involved in spot welding, presswork and final painting due to the use of zinc coatings have, in general, been overcome but there is still scope for improving both materials and techniques.

Materials Used

Hot-Dip-Galvanized Strip

Differentially coated strip (0.15 oz. per sq. ft. on one side and 0.5 oz. per sq. ft. on the other) found favour when associated with spot welding, giving better electrode performance but were more costly. One-side-coated materials were also developed but have found limited use for a brief period. Uniformly coated sheet ($1\frac{1}{4}$ oz. per sq. ft. nominal) with a matt or spangle finish is being used to fabricate sections of the underbody, due to the improvement in quality control and also in the spot welding techniques.

Zinc-Rich Paints

During the last three years one company has progressively replaced zinc-rich painting with hot galvanized strip for the underbody sections,

* Some extracts from a report by K. P. Scott (Imperial Smelting Corporation) and M. H. Davies (Zinc Development Association), published by The Zinc Development Association.

although the latter technique has been retained for treating the mating surfaces of large floor panels and also parts of the internal surface of doors and wings.

Electrogalvanized Strip

Apart from the traditional uses of electrogalvanized sheet, the only new application of note is for the skin panel covering the rear-mounted engine of one vehicle.

Galvonnealed Sheet

This material has not proved successful for normal presswork because of the fragmentation of the coating in the dies.

Practice in Motor-Car Production

Choice of Steel

Standard practice is to supply steel for a particular part and not to rigid mechanical properties, but it is found that slightly higher quality steels are required, as galvanized strip, due to the change in properties at galvanizing temperature.

Aluminium-killed non-ageing steels are used for parts which involve severe drawing and typical properties, quoted by one manufacturer are as follows:

U.T.S.	50,000 lb. per sq. in.
0.2 per cent yield	37,000 lb. per sq. in.
Elongation on 2 in.	38 per cent
Hardness	<50 Rockwell B.
Olsen	380 mm.

Rimming steels are used for parts not so severely worked, and here the hardness may rise to Rockwell B55 or more.

Scribed panels are increasingly being used to assess the ductility requirements, in particular, forming operations, and thus help to define the choice of steel. In some cases it has meant that the more expensive aluminium-killed steels have been replaced by rimming steels.

Coating Weight

The broad requirement is for sheet meeting the following coating weight specification.

Minimum coating weight 0.8 oz. per sq. ft. (both sides) single spot test.

Minimum coating weight 0.9 oz. per sq. ft. (both sides) triple spot test.

Maximum coating weight 1.65 oz. per sq. ft. (both sides).

Finish

Both standard 1¼-oz. per sq. ft. sheet and matt surface with no visible spangle is used for underbody sections. The matt finish is produced by steam cooling and the strip may be given a subsequent pass through grit-blasted rolls in order to produce a "minimized spangle—satin finish" grade for some sections. Sheet is supplied oiled only and not chromated.

Paint Finishes

Galvanized strip is usually confined to the underbody where problems of obtaining a high-quality paint finish do not arise. Some strip is however used for visible parts such as the bottom door sill and there is also a trend towards the use of coated sheet for skin panels. One company used to scuff the exposed galvanized surface using also a Parker 34 phosphating solution followed by normal phosphating of the whole assembly. This practice is being replaced by a single phosphating step which allows a good finish to be obtained on the special grade of hot-dip-galvanized sheet which is preferred for exterior panels. The new phosphating treatment is also claimed to give better chip resistance on coated and uncoated steels.

Zinc-Rich Paints

Although hot-dip-galvanized strip is progressively replacing zinc-rich paints, there will still be some demand for these latter materials. In addition to the spray application of zinc-rich paints to the whole or part of the surface of fabricated sections, there is also interest in the one-side coating of strip by roller techniques. In this case a great deal of development work has been carried out but so far no paint has been developed which will permit forming and also be satisfactory for welding. For spray applications, the zinc-rich paints should be applicable to oily surfaces, should be weldable and also must have satisfactory corrosion resistance. Very many paints were examined and at the present time Ionoclad and Zincolate are probably the most important proprietry paints although several others manufacturers have produced zinc-rich paints which meet the requirements of the motor-car companies. None of them are suitable as a primer for external surfaces.

Other Finishes

Because of the doubt about the suitability of galvanized surfaces as a base for standard external paint finishes, there is still considerable interest in one-side-coated material, and a number of processes for producing this type of product are under investigation.

Electrogalvanized strip is currently being used and it is possible that greater quantities of this material would be required if coatings of adequate thickness could be provided at a cost comparable with hot dip galvanized sheet. Development work is in progress on fast plating techniques.

The conclusion arrived at by the visiting representatives is that although fine-coated sheet, principally hot-dip galvanized, has been established as the most suitable material for certain parts of automobiles subject to severe corrosion, the changes involved in techniques for fabrication, assembly and finishing have been relatively slight.

I.M.F. Conference

(*Continued from page* 344)

virtually all metals, but certainly tin-lead was a lot less susceptible if applied by a hot-dip technique, and this might be significant. They had no experience of tin-lead electrodeposits that had not been flowed. He understood that there was less chance of whisker growth where lead was present but certainly, with hot flow coatings, there had been no trouble on the practical side.

In general, aluminium spray was the preferred finish for services equipment. A good deal was used where part of the surface was enamelled and part left bare for contact reasons. A good deal of zinc spray was used on the telephone side. There had been a few failures of aluminium spray on steel, but they had been rather small and usually associated with the fact that the deposit had been much thinner than it should have been.

In regard to stainless steel being in contact with aluminium-alloy assemblies, he would agree that this was probably a case where, under service conditions, deterioration was less than one would expect from theoretical considerations or accelerated corrosion tests. However, it would be somewhat hazardous to use stainless steel for some marine work.

As everyone knew, copper behaved badly in contact with aluminium. He then showed slides illustrating experiments carried out on sealed cans with various thicknesses of silver plus copper and aluminium. The first, which dealt with thicknesses ranging from less than 0.001 in. to 0.002 in., showed the great extent of corrosion after subjection for a time to humid conditions. The second slide showed the devastating attack that had followed a break in the copper silver deposit on aluminium following the drilling of holes on site. However, if the thickness was correct and no one did that sort of thing, he said, it should be quite satisfactory.

Patterned finishes on aluminium had been used to some extent. He had in mind hammered aluminium, but if used in chassis components the appearance around the weld was very bad. With other types of patterned aluminium, one was up against damage such as might occur during manufacture. Although the hammered aluminium was calculated to obliterate it, one got a certain amount of mechanical damage and the problem was not solved, particularly when there was flame welding.

He realized that he had missed referring to palladium but one slide showed palladium-plated contacts being used on printed circuits. Many people still preferred gold because one required much lower contact pressures. It had a lower contact resistance.

They had experienced problems in connection with the cracking of the deposit due to stress. When subjected to H_2S at rather high concentrations, this showed up effectively. Solderability, in this particular application, had not been involved and their only experience had been in the joint effort mentioned earlier.

Here they had found it quite satisfactory. Palladium was not used on top of silver instead of rhodium because of its inferior electrical properties.

An excellent publication by the Ministry gave all the details of the vast number of conditions under which one got organic vapours. Ventilation was very important where cadmium was present. Where one could not get ventilation it was best to avoid the use of cadmium and use instead something like tin — provided one was not worried about whisker growth. The main trouble was experienced in sealed conditions, such as packing cases, and high humidity.

So far as whisker growth was concerned, they felt that the diffusion of zinc accelerated the process.

Unfortunately, with an alkaline tin on brass, they had not quite got the same results. They appeared to be getting some whiskers on steel, though there were virtually none on copper or nickel-plated brass. Whiskers would, of course, grow on tin under conditions where zinc was absent. He would agree that the flowing of the tin did reduce the effect.

(*To be continued*)

NEW WIRE GALVANIZING PROCESS

A NEW process for galvanizing steel wire has been introduced to this country by AEI-Birlec Ltd. Originally developed in France, the new process offers both economic and technical advantages over the conventional sequence of annealing, pickling, fluxing and dipping. Essentially, the Birlec process eliminates the pickling stages, both of which are costly and highly undesirable procedures. Instead, the wire is annealed in such a way as to permit its direct entry to the zinc bath at correct temperature, thus greatly reducing the heat input needed to keep the bath hot.

Besides the cost savings, the running speed of the wire can be much higher than with the older method. This gives greater production from a given floor space and provides a much improved zinc coating on the wire with virtually no intermediate layer of zinc-iron alloy.

Wire galvanizing by the Birlec process will withstand re-drawing or other severe forms of working which would cause flaking of a conventionally produced coating. The quality of the product is not only high but consistent and both the thickness of coating and the hardness of the wire can be controlled to suit a range of specifications.

FINISHING

NEWS REVIEW

MODIFIED FINISHING SEQUENCE FOR NEW VAUXHALL VICTOR

New Finishing Coat Formulation and Body Design Assist in Production of Long-Lasting Finish

A major feature of the new Vauxhall Victor, shared also by the 6-cylinder models is the new hard, long-lasting, deep-lustre paint finish and the comprehensive under-surface protection.

This is the result of a three-year process development programme, with the objective clearly defined right from the earliest design stages. This programme involved :

1. The design of a body shell free from moisture-retaining recesses, shelves and corners—particularly underneath the body—and of panels on which paint would flow well and adhere strongly whether applied by dipping or by automatic or hand-spraying;
2. revisions and improvements where appropriate to primer and surfacer costs ;
3. the development of a new formula colour-finish to give the best lustre-retention properties and increased wear-resistance.

The body design aspect included a new approach to the floor pressings, replacing narrow indentations in the panels by shallow elliptically-shaped dished depressions, so giving a smoother, cleaner underbody of great strength. Wheel arches have been designed to eliminate corners and pockets which may trap mud thrown up by the wheels. Rebates and shelves have been eliminated wherever possible. New equipment has been installed to assist body shop inspectors to identify minor imperfections of metal-finishing.

Two additional processes are now included in the body protection sequence. The first is a new deep-dip in black primer paint, replacing the previous underbody dip, used by Vauxhall since 1952. The entire body, with the exception of the roof panel, is now immersed in a 5,000-gallon tank. Paint flows around the inner surfaces of the closed box-sections of the body-structure through holes designed solely for the purpose. There is an additional operation for the door-sills of the body. Into these polythene wax with an aluminium filler is pumped by special spray-gun, to protect the inside surfaces.

General view of the new Vauxhall Victor

Second, an additional operation is now provided for the underside of the body, following the paint dip. After double-coats of red-oxide primer-surfacer and grey surfacer have been sprayed on the upper surfaces, a coat of red-oxide primer is sprayed all over the underside of the body, including the wings. This is the foundation upon which a 1/10 in. thick coat of bitumen-based compound is applied—standard practice since 1957—to seal the underbody and wings and reduce road noise.

It is the third section of the development programme in which the biggest advance is claimed. This is the introduction to this country of a new-formula cellulose synthetic enamel, which has very satisfactory hardness and deep-lustre retention properties. Proved by practical usage in Britain and on the Continent, and by long-term exposure tests in several parts of the world, this new deep-lustre finish, on its ideal foundations, ensures that the new cars will keep their good looks for a very long time.

Every Victor body leaving the paint shop at Luton has been protected by the use of no less than 6¾ gallons of paint-protective, corrosion-resisting materials.

The sequence of operation is :—

1. Prepare bare metal.
2. Phosphate coating.
3. Joint-sealing.
4. Primer dip to roof level.
5. Red oxide primer surfacer all over—now including underbody and underside wings.
6. Grey primer surfacer.
7. 1/10 in. coat of tough bitumen/plastic on underbody and underside of wings.
8. Two double coats of cellulose synthetic enamel.
9. Polythene wax containing aluminium pigment pumped inside body door-sills.

FORTH ROAD BRIDGE TO BE ZINC SPRAYED

CHARLES Clifford Ltd., Dogpool Mills, Birmingham 30, have been awarded contracts for the supply of zinc wire for metal spraying the surfaces of the fabricated steelwork to be used in the new Forth Road Bridge, at present under construction.

The specification for the wire is: "Seacliff" Brand zinc wire, 99.95% min. purity, 3/16 in. dia. + nil—0.002 in., in endless coils weighing approx. 5 cwt. each.

The wire is carried in specially designed heavyweight returnable containers with close fitting quick-release lids which are moisture proof, thereby enabling the wire to be kept in perfect condition under almost any conditions of storage on site. The supply feed to the automatic metal spraying equipment is direct from the container and the construction of the containers renders them readily transportable.

The contract for the superstructure of the bridge is being undertaken by The A.C.D. Bridge Co., a consortium formed by Sir William Arrol and Co. Ltd., The Cleveland Bridge and Engineering Co. Ltd., and Dorman Long (Bridge & Engineering) Ltd. About half of the metal spraying will be carried out at The A.C.D. Bridge Co.'s depot at Drem, East Lothian, Scotland, using automatic metal spraying equipment, designed and manufactured by Charles Clifford's associate company, Metallisation Ltd., Dudley, Worcs. The remaining work will be carried out at the works of The Cleveland Bridge and Engineering Co. Ltd., at Darlington and it is estimated that about 450 tons of wire will be used in connexion with the project. The bridge is being constructed for The Forth Road Bridge Joint Board and the engineers are Mott, Hay and Anderson and Freeman Fox and Partners.

AUTOMATIC *p*H CONTROL

THE use of automatic *p*H control is making an ever-increasing contribution to the efficiency of present day industrial processing.

An example of this recently occurred in the extensive metal pretreatment facilities at Marshall Motor Bodies Ltd., Cambridge. As these facilities operate on a round-the-clock basis, any process stoppage constitutes a serious and considerable loss in time and money.

For the heating of degreasing, de-rusting, and Parkerising tanks, a closed-circuit heating system is employed. The fracture of a steam heating coil allowed Parkerising solution to return to the boiler with the condensate return water. This caused heavy deposits to form on the boiler tubes resulting in a complete loss of boiler efficiency, complete loss of production for 50 days, and necessitated complete overhaul of the boiler, including replacement of boiler tubes.

To prevent any recurrence of this costly breakdown, Pye Industrial *p*H equipment was installed to monitor continuously the *p*H value of the boiler condensate return water before its return to the boiler make-up tank. Within seconds of a heating coil fracture and entry into the heating system of process solutions, the *p*H sensing element measures the resultant change in *p*H value and immediately diverts contaminated return water to waste, at the same time operating a warning signal.

During the past twelve months of plant operation two coil fractures have occurred. In each instance contaminated condensate return water was automatically diverted to waste, thus preventing serious boiler damage.

RUSH ORDER FOR JAPAN

G. A. Willis, Ltd., paint and plastic manufacturers of Aycliffe Industrial Estate, Co. Durham, recently received an order for 2,000 gallons of their Teesport liquid lead, required urgently in Japan. To meet the conditions of this order, it was necessary to have the consignment delivered to a Continental port within 48 hours of receipt of notice, for transhipment. This delivery was effected with an hour to spare.

"Teesport" is a specialized quick-drying, rust-inhibiting red lead primer which has considerable sales in marine and industrial fields, both in this country and abroad.

A recent discovery by the company of a plastic coating which bonds to steel has aroused intense interest and a special plant for its application is in the course of construction at Aycliffe by Dorman Long, who intend to apply it to steel sheet. Later, it is expected that this treatment will be extended to steel girders and ships' plates.

FIRST PAINT FACTORY FOR NIGERIA

INTERNATIONAL Paints are pioneering the local manufacture of paint in Nigeria. Their new factory, which is now being built at Ikeja 14 miles N.W. of Lagos, adds one more link to their chain of 26 paint manufacturing plants throughout the world.

The latest paint-making machinery is to be installed in the factory, and emphasis has been placed on the provision of the best possible working conditions. The layout allows for 100 per cent expansion in production without affecting the natural production flow from raw material to finished product.

Mr. P. Whelan, who will soon be taking up his appointment as works manager at Ikeja, joined International Paint in 1951. He was works manager of the London factory from 1953-1958 and since then he has held various posts both at home and overseas.

Aluminium-Based Paint For Electrostatic Application

AN aluminium-based polychromatic paint which can be applied with any electrostatic hand gun is the latest addition to the range of Vulcan finishes manufactured by the Industrial Division of Blundell, Spence and Co. Ltd.

Until now it has been difficult to spray metallic paints with an electrostatic hand gun because of the rapid build-up of deposited metal in the paint feed line. This provided a path for the high voltage electrostatic charge to leak away to earth, preventing the system from operating.

The new paint, developed by Blundell Spence at their Slough laboratories, is said to overcome this problem. It is a one-coat finish, and can be either air-dried (30 minutes) or stoved (20 minutes at 240° to 250° F.).

At present the new paint is available only in silver-grey, which dries to a semi-gloss finish.

It is recommended for a variety of articles, including tubular steel furniture, agricultural and dairy equipment and domestic articles. It can also be applied by normal air spray and airless spray.

CHANGE OF ADDRESS

METAL Pretreatments Ltd. have now moved to Abbot Close, Oyster Lane, Byfleet, Surrey. Telephone: Byfleet 42581, 46001, 46141.

S.C.O.W. ORDER NEW GALVANIZING LINE

THE Head Wrightson Machine Co. Ltd., Middlesbrough, a subsidiary of Head Wrightson and Co. Ltd., have received an order from the Steel Company of Wales for an Armco-Sendzimir continuous hot-dip galvanizing plant to be installed at Abbey Works, Port Talbot. Head Wrightson are the main contractors for the plant, and the furnace for annealing and surface preparation will be built by AEI-Birlec.

The plant will be capable of galvanizing cold-reduced strip up to 54 in. in width and from 0.015 in. to 0.062 in. thick at a processing speed reaching 150 ft. per min.

This line will incorporate all the latest developments in continuous galvanizing and will be designed by The Head Wrightson Machine Co. in conjunction with their American associates Blaw Knox Co., Aetna Standard Division, who have built more than half of the continuous galvanizing lines at present in operation throughout the world.

The total value of the contract, excluding the civil work and electrical equipment is approximately £500,000.

S.C.I. CORROSION GROUP EXHIBITION IN BIRMINGHAM

A SPECIAL exhibition of items relating to metal corrosion and its prevention, which was assembled by the Corrosion Group of the Society of the Chemical Industry, has been re-arranged as a Travelling Exhibition by the Science Museum, South Kensington. This collection has been lent to the Department of Science and Industry of the Birmingham City Museum, Newhall Street, Birmingham 3, and will be on show to the public until the end of September.

It has been estimated that the yearly cost of corrosion to Great Britain alone is in the order of £600,000,000 (£12 per head per annum). The prevention of corrosion is, therefore, a problem of great national economic importance and of interest even to the layman.

By suitable exhibits corrosion is shown as a natural reversal of the process of extracting metals from their ores and a wide variety of corrosive environments is briefly indicated : the atmosphere, natural waters and process liquids, burial underground, the effect of bacteria, high-temperature oxidation and the combined action of corrosive and mechanical influences.

Corrosion may be prevented in many ways, though proper design is always essential if the preventive measures are to be applied economically and effectively. The choice of the correct metal or alloy may call for a noble metal, a material with a resistant oxide film, a material forming an insoluble resistant corrosion-product or a material containing alloying additions intended to meet special requirements.

The electrochemical and other methods of control are dealt with but the whole exhibition is designed to explain the causes of trouble and their possible remedies.

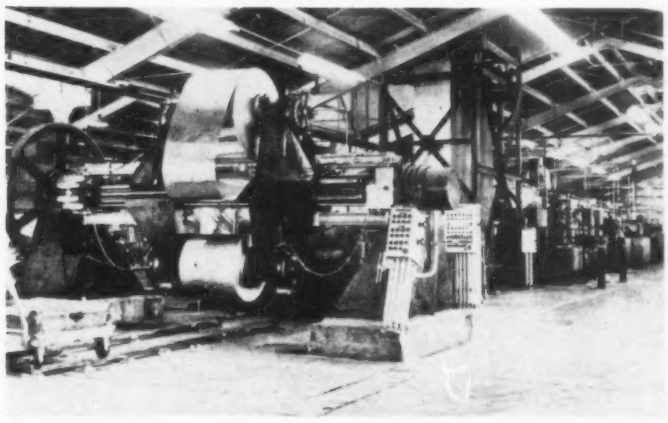
Hours of Opening : Monday to Friday—10.30 a.m. to 6.0 p.m., Saturday : 10.0 a.m. to 6.0 p.m., Sunday : 2.0 to 5.30 p.m. First Wednesday in each month : 10.30 a.m. to 9.0 p.m. On and after October 1, 1961, the Museum will close at 5.30 p.m. instead of 6.0 p.m.

A NEW INDUSTRY FOR THE NORTH-WEST

REPRESENTATIVES of local newspapers recently visited the headquarters of T. and T. Vicars Ltd., at Earlestown, Lancs. Their host was Henry Simon Ltd. (a company of Simon Engineering Ltd.) who called the press conference to announce its decision to manufacture the Simon-Waldron range of web coating machinery at Vicars, a sister company.

Illustrated is a view from the entry end of a coating line for 60-in. wide metal strip. This unit is capable of running continuously at speeds up to 150 ft. per min.

The manufacture of Simon-Waldron machinery will provide new employment for about 50 engineers and draughtsmen and 250 factory workers, and recruitment will begin in the autumn.



Panel to Aid North Midland Exporters

THE North Midland Regional Council of the Federation of British Industries has organized a panel of export experts to assist smaller firms in the problems of exporting. Members of the panel are prepared to give practical and personal help to novice exporters within the same industry or type of industry.

The local Chambers of Commerce, the N.U.M. and four local hosiery manufacturers' Association have pledged their support for the panel.

The panel consists of 14 members covering the principal industries in the North Midlands, including engineering, furniture and plastics.

New Arrangements for Producing Refractory Coatings

FURNASCOTE refractory coatings formerly manufactured and marketed by Corrosion Ltd., of Southhampton, will in future be manufactured and marketed by Furnascote Ltd., 16/18, Malvern Road, Southhampton — Telephone, Southampton 71347. All enquiries and correspondence should be sent to the sales director, Mr. G. L. Barron, A.I.R.I. (Sc.).

SYNTHETIC ACIDS IN PRODUCTION

DEVELOPED after extensive research by the Shell laboratories in Amsterdam, a new group of synthetic organic acids is now available from a pilot-plant, and will be produced on a commercial scale as from January next.

The acids are being marked under the trade name " Versatic " Although similar in some respects to other organic acids already on the market, the new acids are claimed to possess unique properties which will find important applications in the surface coatings, plastics, rubber, metallurgical and many other industries.

A £2M. plant to handle the acids when they go into commercial production is now under construction at Shell's large oil and chemical refinery complex at Pernis near Rotterdam.

" Versatic " acids are produced from olefins, carbon monoxide and water by a process developed by Shell from the original work of Dr. H. Koch, of the Max Planck Institut für Kohlenforschung, at Muelheim, Germany.

It is expected that eventually a full range of " Versatic " acids will be made available : the present samples, however, and the acids in full production in 1962, are a blend of C_9, C_{10} and C_{11} mono carboxylic acids. The acids are fully saturated and highly substituted on the carbon atom adjacent to the carboxylic group — there are no acids present having two alpha hydrogen atoms, and only 10 per cent. contain one alpha hydrogen atom ; some cyclic material occurs among the remaining 90 per cent. of the product which has no alpha hydrogen atom. The value of this high degree of branching in the structure of " Versatic " acids lies in the great stability against hydrolysis of the esters which can be made from them. Such esters are of interest as plasticizers, while resins based on " Versatic " acids are expected to possess exceptional chemical stability.

FORTHCOMING MEETINGS

September 18

Institute of Metal Finishing (London Branch). " Plating of Zinc-based Die-castings " by J. Edwards, at Northampton College of Technology, St. John Street, London, E.C.1. 6.15 p.m.

September 19

Institute of Metal Finishing (South-West Branch). " Duplex Nickel Plating " by J. W. Weaver, at the Royal Hotel, Bristol. 7.30 p.m.

September 29

Institute of Metal Finishing (Sheffield and North-East Branch) " Plating Shop Layout and Installation " by C. R. Darby, at the Grand Hotel, Sheffield. 7 p.m.

Technical Advice Agreement

LAPORTE Titanium Ltd., a subsidiary of Laporte Industries Ltd., have entered into an agreement with the Argentine company, Titanit Compania Industrial do Pigmentos y Afines S.A., to provide technical assistance and advice to enable them to modernize and extend their plant.

Titanit have been manufacturing titanium oxide for some years in a small plant at Pilar near Buenos Aires.

The arrangement is on a royalty basis and there is no agreement for financial collaboration between the two companies.

Titanit are the sole manufacturers of titanium oxide in the Argentine.

Service for Disposal of Waste Chromic Acid

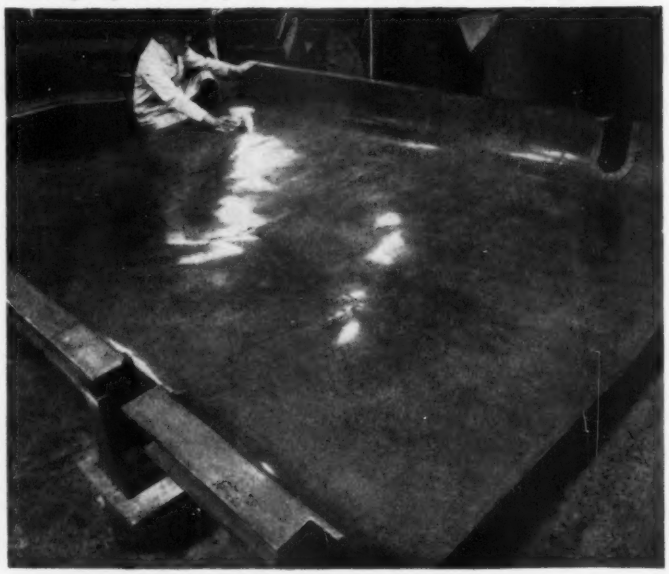
ASSOCIATED Chemical Companies (Sales) Limited, PO box No. 6, Brotherton House, Westgate, Leeds 1, announce the introduction of a service to consumers of chromic acid for the disposal of their waste chrome plating liquors. A leaflet is obtainable from the company which briefly outlines the procedure to be adopted by those interested in taking advantage of this service, and giving information about the arrangements made for acceptance and treatment of the waste liquors.

EPOXY RESIN AND GLASS FIBRE COVER FOR A PICKLING TANK

A LARGE steel company has recently ordered from Parglas Ltd. of Bristol, a giant sectional cover for a 400-ft. long pickling tank.

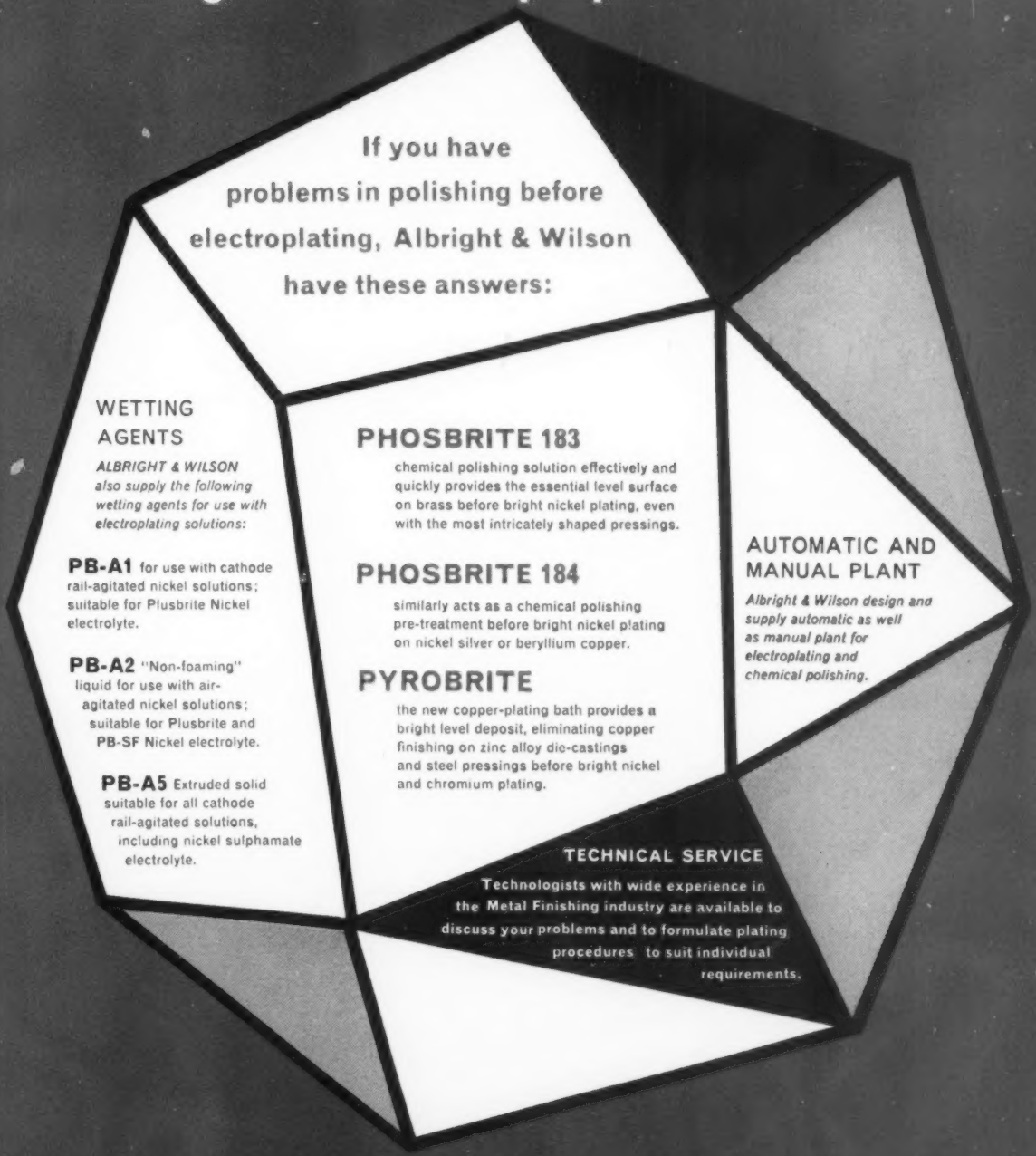
Owing to the highly corrosive nature of the chemicals used in this tank, it was decided to make the cover completely out of " Araldite " epoxy resin and glass fibre.

The complete cover consists of 37 varying sections of 8 ft. 6 in. wide. The sections, which were designed by Parglas Ltd., are of sandwich construction consisting of " Araldite " and glass-fibre outer skins, with an " Araldite " impregnated honeycomb core. This type of construction gives great rigidity for very little increase in weight. The covers were manufactured on matched moulds giving the necessary smooth surfaces to prevent attack by crystallization.



METAL FINISHING FROM A TO Z

Albright & Wilson prepare for action...

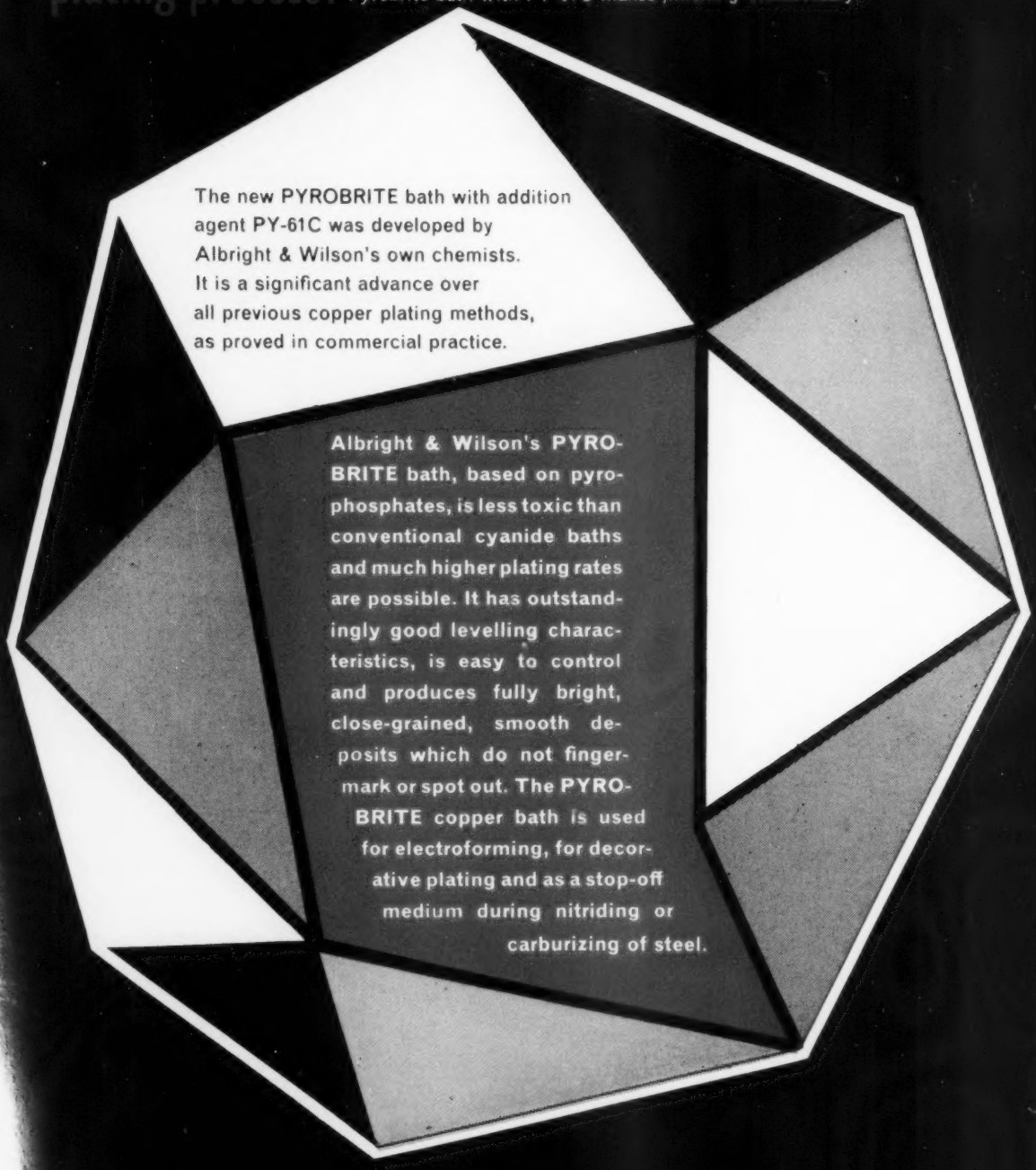

If you have problems in polishing before electroplating, Albright & Wilson have these answers:
WETTING AGENTS
ALBRIGHT & WILSON also supply the following wetting agents for use with electroplating solutions:
PB-A1 for use with cathode rail-agitated nickel solutions; suitable for Plusbrite Nickel electrolyte.
PB-A2 "Non-foaming" liquid for use with air-agitated nickel solutions; suitable for Plusbrite and PB-SF Nickel electrolyte.
PB-A5 Extruded solid suitable for all cathode rail-agitated solutions, including nickel sulphamate electrolyte.
PHOSBRITE 183
chemical polishing solution effectively and quickly provides the essential level surface on brass before bright nickel plating, even with the most intricately shaped pressings.
PHOSBRITE 184
similarly acts as a chemical polishing pre-treatment before bright nickel plating on nickel silver or beryllium copper.
PYROBRITE
the new copper-plating bath provides a bright level deposit, eliminating copper finishing on zinc alloy die-castings and steel pressings before bright nickel and chromium plating.
AUTOMATIC AND MANUAL PLANT
Albright & Wilson design and supply automatic as well as manual plant for electroplating and chemical polishing.
TECHNICAL SERVICE
Technologists with wide experience in the Metal Finishing industry are available to discuss your problems and to formulate plating procedures to suit individual requirements.

TURN PAGE FOR IMPORTANT NEWS ABOUT COPPER PLATING!

METAL FINISHING FROM A TO Z

Albright & Wilson develop outstanding new copper plating process!

Pyrobrite bath with PY-61C makes finishing unnecessary!



The new PYROBRITE bath with addition agent PY-61C was developed by Albright & Wilson's own chemists. It is a significant advance over all previous copper plating methods, as proved in commercial practice.

Albright & Wilson's PYROBRITE bath, based on pyrophosphates, is less toxic than conventional cyanide baths and much higher plating rates are possible. It has outstandingly good levelling characteristics, is easy to control and produces fully bright, close-grained, smooth deposits which do not fingermark or spot out. The PYROBRITE copper bath is used for electroforming, for decorative plating and as a stop-off medium during nitriding or carburizing of steel.

METAL FINISHING FROM A TO Z

Four Albright & Wilson advances in nickel plating!

Whatever your nickel plating problem—A & W have an answer that's right for YOU!
PLUSBRITE NICKEL
plating bath. Combines the seven major requirements for effective bright nickel deposits.
• Low cost
• Fully bright deposits of excellent colour
• Excellent levelling properties
• High ductility
• Good reception to chromium plating
• Easy control
• High speed deposition
SBSF
for semi-bright nickel plating at high speed, a stable, sulphur-free addition agent which gives the bath excellent levelling characteristics. This semi-bright deposit is intended for use with Plusbrite nickel as part of an excellent duplex system. It is also useful as a fast-plating, semi-bright solution.
PLUSBRITE DUPLEX
is for use where excellent corrosion resistance and maximum ductility is required with a fully bright finish.
The addition agents do not produce harmful breakdown products and are not removed by continuous filtration through carbon.
NICKEL SULPHAMATE
provides a bath for rapid plating of heavy nickel deposits, with superior ductility and low internal stress. It is used in the production of gramophone record stampers, in electroforming, in the re-sizing of worn parts and in facing of stereos and electrotypes.

NEWS ABOUT SILVER AND TIN PLATING OVERLEAF

METAL FINISHING FROM A TO Z

Albright & Wilson lead the field in silver & tin plating!

FOR SILVER PLATING

Plusbrite Silver addition agents give first-class results for:

* *Plating of electrical and electronic components. The deposit is unalloyed, retaining its full electrical conductivity.*
* *Plating of decorative silver, tableware, cutlery, jewellery and musical instruments.*
* *Plating engine bearings where minimum lubrication is available.*

The Plusbrite silver plating bath provides:

* *A fully bright deposit over an extremely wide current density range.*
* *The possibility of very high plating rates.*
* *A hard (110 V.P.N.) and tarnish resistant deposit.*
* *Elimination of finishing in many cases.*

FOR TIN PLATING

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* *Less sludge and greater ease of control.*
* *Further improvements by using "high speed" tin anodes.*

For Immersion Deposition

* *Reduced sludge formation.*
* *In the Phostin process for aluminium the solution composition is modified to provide a self-regulating bath needing infrequent discarding.*

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TECHNICAL *and* INDUSTRIAL APPOINTMENTS

Mr. E. J. Robinson has been appointed a director of **The Head Wrightson Export Co. Ltd.,** which is responsible for the development of trade in overseas markets for the Head Wrightson companies.

Mr. R. F. N. Otway has joined The Head Wrightson Export Co. Ltd., as Manager—Europe. Before taking up this appointment Mr. Otway was with The Morgan Crucible Co. Ltd.

* * *

The Pyrene Company Ltd. have appointed Mr. H. A. Holden (Manager—Metal Finishing Division) a divisional director. Mr. Holden has been closely associated with the study of corrosion and metal finishing for many years.

Mr. A. Nicholson (Chief Chemist) is appointed a divisional director (Chemistry). He joined the company in 1939 and was appointed Chief Chemist in 1943. He will be responsible for the direction of the company's chemical activities. Mr. Nicholson, who is in charge of all the Pyrene laboratories, has for many years made a close study of the development of fire extinguishing media and metal treatment processes.

* * *

Mr. Donald H. Morris has been appointed Chicago District manager by **Hanson-Van Winkle-Munning Co.** Mr. Morris takes the place of Ralph R. Granquist who recently retired.

Mr. Morris joined the company in 1955 as a field electrochemist. He is a 1941 graduate of Colgate University and holds an A.B. in Chemistry.

* * *

Laporte Industries Ltd. announce that Mr. B. H. Oldfield, director and engineering manager of Laporte Chemicals Ltd., is to retire. He will be succeeded as engineering manager by Mr. Maurice Ruddick.

Mr. Oldfield joined Laporte Chemicals Ltd. in 1947 from the Ministry of Supply. When the Engineering Construction department of Laporte Chemicals Ltd. was first established in London in 1954, Mr. Oldfield took charge of it and in 1959 he became a director of the company.

Mr. Ruddick gained a B.Sc. (Engineering) degree at Durham University. After serving as an engineer officer in the Royal Navy he joined C. A. Parsons Ltd. and spent two years on the development of gas turbines. During this time he was awarded a Whitworth Senior Scholarship which he applied at Queen Mary College, London University. There he gained his Ph.D. (Engineering) and was awarded a Clayton Fellowship of the Institution of Mechanical Engineers. He then joined I.C.I. Alkali Division, and a year later was seconded to Cambridge University, where he became a B.A. (Chemical Engineering). He returned to I.C.I. and spent a further five years there before joining Laporte Chemicals Ltd. as assistant engineering manager in May 1960.

* * *

Mr. D. R. Walker, A.C.C.S., has been appointed Secretary of the **Vitreous Enamel Development Council,** and the registered offices have been transferred from 11, Ironmonger Lane, London, E.C.2. to 28 Welbeck Street, London, W.1. (Hunter 2237). The general manager of the Council is Commander G. Clarke, F.C.C.S.

* * *

Blythe Colour Works Ltd., announce that departmental managers, Mr. W. V. Hedges and Mr. E. H. Leadbeater, have been appointed additional directors of the company.

In contributing to the growth of the company they joined from school, each has given more than thirty years' service and this is recognized by further responsibility.

* * *

Mr. A. C. Sturney has been elected to the board of the **International Nickel Co. (Mond) Ltd.** He relinquishes his appointment as general manager of publicity, bringing direct to the board his long and outstanding experience in the field of publicity and marketing.

Mr. Sturney will be succeeded as general manager of publicity by Mr. L. F. Denaro, who will relinquish his appointment as assistant to the managing director.

OBITUARY

PIPE : F. W. Berk and Co. Ltd. announce with deep regret the recent death of Mr. E. L. Pipe at the early age of fifty. Mr. Pipe joined the company in January 1937. During the war he saw active service overseas in the Army and since 1946 had continuously represented the company in the foundry industry. Well known in foundry circles over a wide area, particularly the Midlands, S. Wales and the West, Mr. Pipe will be greatly missed by his many friends.

A.I.D. APPROVE ELECTROLESS NICKEL AND CHROMATE-CONVERSION PROCESS

ROTO-FINISH, Ltd., Mark Road, Hemel Hempstead, have received AID approval for their "Cahill" electroless nickel process and their "Tridur AL" chromate conversion process for aluminium under D.T.D. Specification No. 900/4728 and 900/4729 respectively.

The Cahill electroless nickel process is a method of plating by chemical reduction and is claimed to produce a semi-bright, hard (VPN 450/550) coating of nickel/phosphorus alloy 90 to 92 per cent nickel—8 to 10 per cent phosphorus) on a variety of base metals : steel, copper alloys, aluminium.

The process is operated hot' 88/93°C, on a small scale in a glass or vitreous-enamelled beaker or on a larger scale in special glass-lined tanks with electrothermal heating jackets. It requires no electric current or anodes, hence no problem in throwing power. Intricate and irregular shapes can be plated uniformly (± 10 per cent max. of the coating thickness). By a suitable heat treatment (1 hour at 400°C.) the hardness can be increased to 1,000 VPN.

The process can be used for building up components machined undersize, for corrosion resistance, where it can replace expensive stainless or clad alloys. The exceptional hardness of the alloy plate makes it particularly suitable for use on components where wear is a problem.

Tridur Al conversion treatment for aluminium and its alloys gives a high rate of corrosion resistance and maximum paint adhesion. Coatings are produced in 20 seconds to a maximum of 3 minutes, producing a yellow to khaki colour which can be dyed with various coloured aniline dyes if required.

BECK : Laporte Industries Ltd. regret to announce the recent death of Mr. Clarence Walker Beck, a director of Laporte Acids Ltd. and manager of the Hunt Works, Castleford, of that company. Mr. Beck, who was 64, was due to retire next year.

He joined Hunt Brothers (Castleford) Ltd. in 1924 and became a director of the company and also of John Nicholson and Sons Ltd. of Hunslet. He remained a director when these companies amalgamated under the name Laporte Acids Ltd.

* * *

CHARLES : The directors of Blythe Colour Works Ltd., regret to announce the death of Mr. W. E. Charles.

Mr. Charles had been with the Company over thirty years and was in charge of administration in the Blythe Colour Works laboratories.

British Standard for Electroplated Coatings on Threaded Components

PARTS 1 and 2 of a new British Standard dealing with the plating of small threaded components such as bolts, screws and nuts, have been published as one booklet (B.S.3382 : Parts 1 and 2). They deal with thicknesses of plating which, without preventing the assembly of threaded components, will ensure satisfactory protection against corrosion.

Introductory notes explain the problems associated with the electroplating of threaded components and the need for special procedures for thickness specification, inspection sampling and thickness determination.

As well as specifying plating thicknesses, sampling and other inspection procedures, and methods of thickness determination, this publication lays down requirements for the purity of the plating, for reduction of hydrogen embrittlement for finish and appearance of plated surfaces, and for passivation. In the case of cadmium plating, requirements are also laid down for adhesion and for freedom from gross porosity. Tables of surface areas of standard screws, bolts and nuts are given as a guide to electroplaters, so that they may estimate the conditions of current and plating time needed to obtain the required deposit thickness, and also to assist in the estimation of average thickness on plated components.

The plating thicknesses laid down are intended for components having threads of basic major diameters from 0.060 in. to $\frac{3}{4}$ in. inclusive, specified in B.S.84, 93, 811, 1580, 1095 and 2779. The publication refers in particular to the general purpose bolts, screws and nuts specified in B.S. 57, 450, 1083, 1768, 1981 and 3155.

The plating thicknesses specified will be adequate for most purposes but under severe conditions, greater protection may be needed. In such cases, reference should be made to Part 7 B.S.3382, to be published in due course under the title, "Thicker plating for steel components." Other parts will deal with nickel and nickel/chromium on steel components, nickel and nickel/chromium on brass components, tin on brass components and silver on brass components.

Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1, price 7s. 6d. each. (Postage will be charged extra to non-subscribers).

PVC COATING FOR FENCING PANELS

THE head office of Technicolor Ltd. faces onto a busy main road adjacent to London Airport. Until recently the company used a wire fence to separate their premises from the footpath, but when it was necessary to replace this fence, they chose metal fencing panels with a coating of Geon PVC.

Coating was carried out by Plastic Coatings Ltd., Guildford, by dipping in a paste based on Geon PVC paste resin. The resultant finish has a high gloss, with a colour fastness far superior to that of paint. The coating also has excellent adhesion to its substrate. Moreover, PVC is weather-resistant and thus the fence is expected to require no maintenance. The costly business of regular repainting has been eliminated ; the permanent coating ensures that the fence remains corrosion free, thus retaining its neat attractive appearance.

In all, 45 panels were used to construct this fence. Each panel is 8 ft. 6 in. long, 4 ft. 6 in. high, and has been coated to a thickness of 1/16 in. With PVC dipping, the panel is coated in one operation and costly handwork is avoided. This method also allows accurate control over the thickness of the coating.

Geon PVC is made by British Geon Ltd., a Company in Distillers Plastics Group.

Rapid Analysis of Acid Gold-Alloy Plating Solutions

QUICK, accurate analysis of acid gold alloy plating solutions obtained by polarographic methods are described in a 3-page paper by Dr. Kark Schumpelt and Arnold H. Craft of Sel-Rex Corporation, Nutley, N.J.

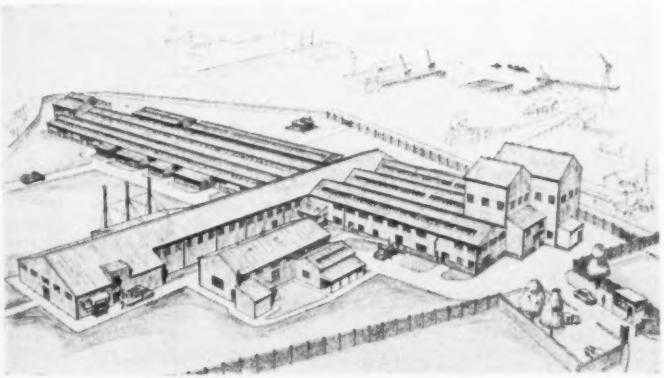
Originally presented to the American Electroplating Society, Newark Branch, and published in Plating Magazine, this paper has been reprinted as a technical service by Sel-Rex for electroplaters who must meet or exceed exacting government and industrial specifications requiring precise control of acid gold alloy electroplate.

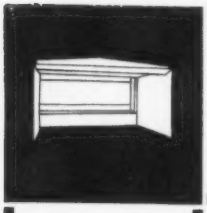
Reprints of this paper entitled "Polarographic Methods for the Analysis of Acid Gold Alloy Plating Solutions" are available free of charge from Sel-Rex Corporation, Nutley 10, New Jersey, U.S.A.

NEW CHEMICAL ENGINEERING FACTORY

THE President of the Kestner Evaporator and Engineering Co. Ltd., of London, recently unveiled a plaque to commemorate the inauguration of their new foundry at Greenhithe. This foundry is the first part of the complete move of their works from New Cross to Greenhithe. Other shops that will be transferred will be the Keebush production and machine shop, grinding, pump assembly and test, Keeglas and PVC fabrication, general and heavy plant erection, and finally the general laboratory, pilot plant, and test laboratory. A new drawing office is being built to house 60 draughtsmen. On completion the factory floor will be some 100,000 sq. ft. The move will be completed in about 6 months.

The illustration shows an artist's impression of the final shape of the works.





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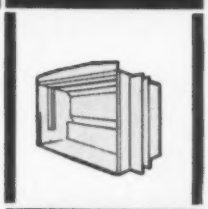
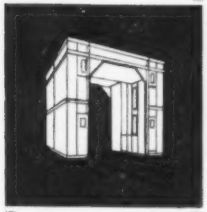
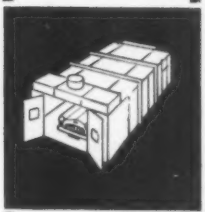
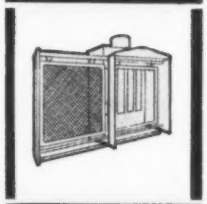

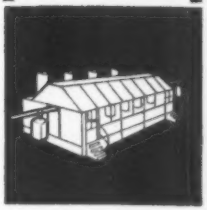

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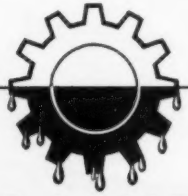

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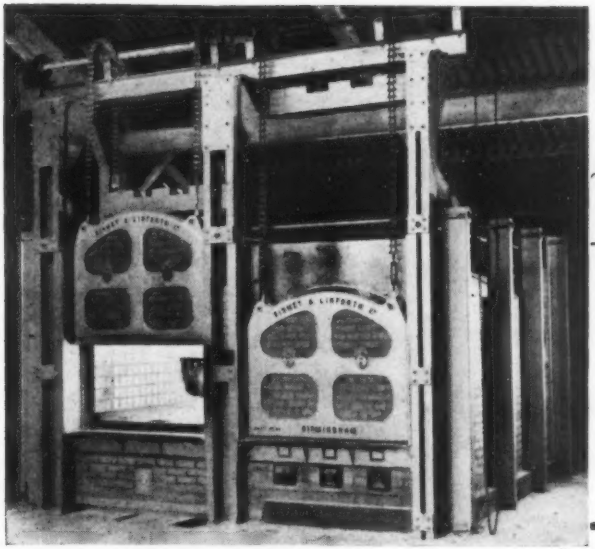

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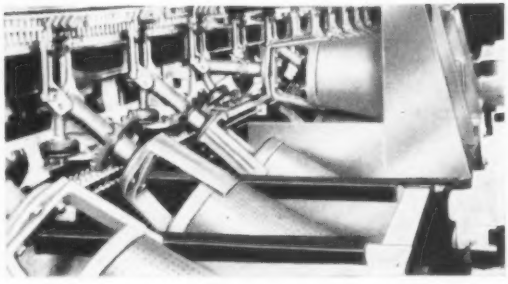

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Ammonium Citrate	✓	✓	✓	✓					
Gluconic Acid	✓	✓	✓	✓					
Glucono Delta Lactone	✓	✓	✓	✓					
Sodium Gluconate	✓	✓		✓					
Ammonium Oxalate	✓	✓		✓					
Ferric Ammonium Oxalate									✓
Tartaric Acid	✓		✓	✓				✓	
Tartar Emetic				✓					
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